# Nantucket Memorial Airport Master Plan Update

***Appendix 1- Noise Analysis***

**2015**

Prepared for:
**Nantucket Memorial Airport Commission**

**Prepared By**

JACOBS

**Jacobs Engineering**

In association with

RLM

**Robin Lee Monroe & Associates**

# Appendix 1 – Noise Analysis

KM Chng Environmental Inc.

# MEMORANDUM

To: Bill Richardson (Jacobs)

From: Rich Letty and Martin Brien (KM Chng)

Subject: August 2013 Nantucket Airport Noise Study

Date: 15 November 2013

The following memo contains the results of an analysis of the existing environmental noise in the vicinity of Nantucket Memorial Airport on Nantucket Island, Massachusetts. The study was conducted during the week of August 15-20 to be representative of a busy summer weekend period when the airport operations are at a maximum.

## EXECUTIVE SUMMARY

During the week beginning on Wednesday, August 15, 2013, noise measurements were obtained at several locations in the vicinity of Nantucket Memorial Airport. The primary purpose of the noise study was to quantify the level of environmental noise at typical residential locations both north and south of the airport. The late August time period was selected to be representative of a busy summer weekend period when the aircraft activity at the airport is at a maximum. Aircraft operations are one of the main sources of environmental noise for residents living close to the airport runway centerlines. During the measurement program, data was also collected for individual aircraft events, and airport apron ground operations.

The measurements included A-weighted hourly Leq levels that were obtained for five consecutive days at six residential locations within a mile or two of the airport. Additional A-weighted hourly Leq levels were obtained for two days at two other locations, one of which corresponds to one of the residential locations used in our previous noise studies, and the other which was located adjacent to the airport property line. The resulting measurements were reduced to average Leq and DNL for the total time period. The DNL level includes a 10 dB penalty for nighttime operations. [It should be noted that the airport does not normally operate during nighttime hours].

The results of the measurements indicated that the Leq five-day average at the six residential locations varied from approximately 51-58 dBA, and the DNL varied from 53-63 dBA. The hourly background, or L90 levels, varied from approximately 40-44 dBA. Typical background levels included local traffic, children playing, and the sound of the surf at locations south of the airport. The level from most aircraft takeoffs and landings was in the 50-60 dBA range, and largely account for the measured Leq. However, one of the six locations included new home construction activities, which probably dominated the Leq, and was more conspicuous than aircraft noise. In some cases the higher of the DNL levels may reflect summer nighttime activities not related to the airport such as insect noise from crickets.

The two additional measurement locations, which were both very close to the airport, showed Leq two-day averages from approximately 61-64 dBA, and DNL two-day averages from approximately 62-67 dBA. The first of these locations at the end of Okarwaw Avenue was a residential location that also included considerable new home construction activity. The second location was adjacent to the airport and included noise from airport ground operations and nearby traffic on Monohansett Road.

**FIVE-DAY HOURLY Leq MEASUREMENTS**

Six locations were selected in each of the quadrants around the airport on Nantucket Island. The selection process was determined by the Airport Commission. Figure 1 shows the locations and Table 1 lists the addresses of the properties. As seen in the figure, the locations represent typical residential areas that are influenced by the noise produced by airport operations.

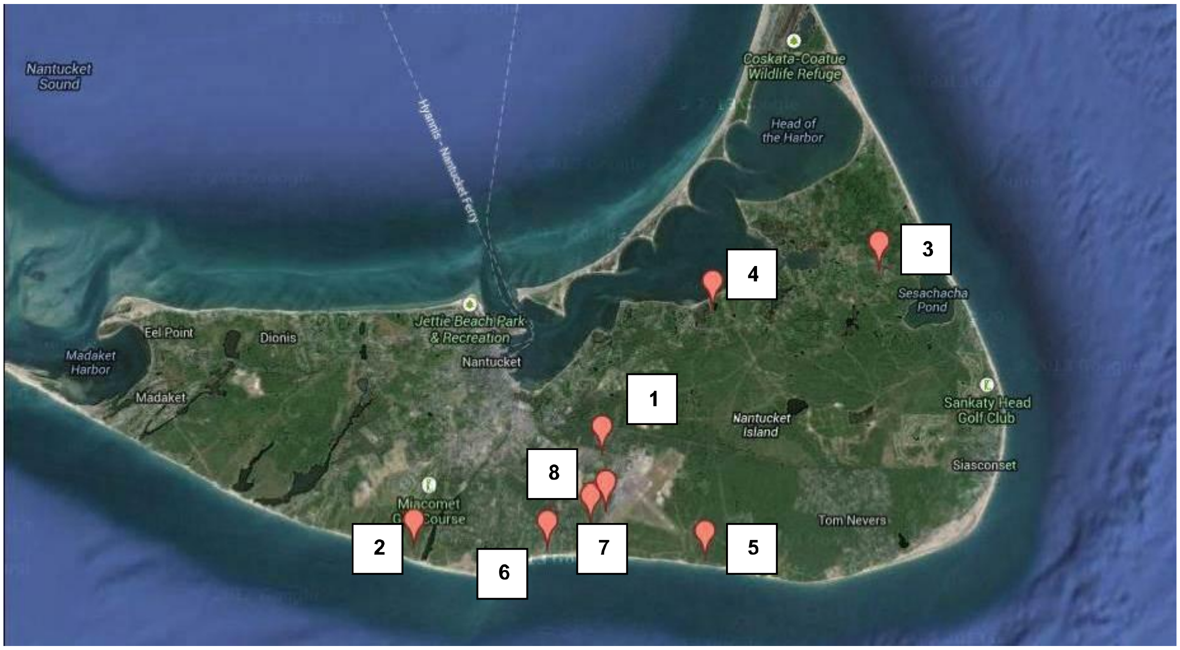



**Figure 1 Aerial View of Nantucket Showing Measurement Locations**

**Table 1 Five-Day Measurement Location Addresses**

| Measurement Location | Address | Position from Airport |
|---|---|---|
| 1 | 84 Egan Lane | Northwest |
| 2 | 53 West Miacomet Road | Southwest |
| 3 | 7 Briarpatch Road | Northeast |
| 4 | 180 Polpis Road | Northeast |
| 5 | 18 Waiquoit Road | Southeast |
| 6 | 35 Nobadeer Avenue | Southwest |

The results of the noise monitoring at these locations are shown in Table 2, which includes the five-day average Leq, DNL, Lmax, Lmin, L10, and L90 (with the exception of Location 5, for which the L10 and L90 were not available due to equipment capability). Figure 2 shows the DNL levels on the aerial view of the island. It can be seen that noise levels did not vary that much at the different noise measurement locations, and are representative of typical small airport activity. Some local events were also a factor in the noise levels. In particular, all the locations showed higher noise levels on approximately the fourth day of measurements (8/19), which may be attributable to weather events. This can be seen in Figure 3, which shows a composite view of the hourly Leq levels during the five-day measurement period. The figure also shows that there were some high noise level events at Location 1 on approximately 8/16 and 8/18, and at Location 6 between 8/19 and 8/20.

**Table 2 Five-Day Average Measurement Results**

| Measurement Location | **Leq** (dBA) | **DNL** (dBA) | **Lmax** (dBA) | **Lmin** (dBA) | **L10** (dBA) | **L90** (dBA) |
|---|---|---|---|---|---|---|
| 1 | 54.1 | 62.5 | 77.3 | 40.4 | 51.6 | 42.8 |
| 2 | 50.9 | 53.1 | 73.5 | 33.7 | 53.1 | 39.5 |
| 3 | 54.5 | 56.3 | 73.2 | 39.3 | 49.6 | 46.8 |
| 4 | 54.7 | 56.7 | 75.1 | 40.5 | 57.6 | 44.1 |
| 5 | 57.5 | 63.2 | 84.0 | 35.6 | NA | NA |
| 6 | 55.4 | 58.6 | 83.2 | 35.2 | 57.2 | 40.2 |


**Figure 2 Five-Day Average DNL Noise Levels**

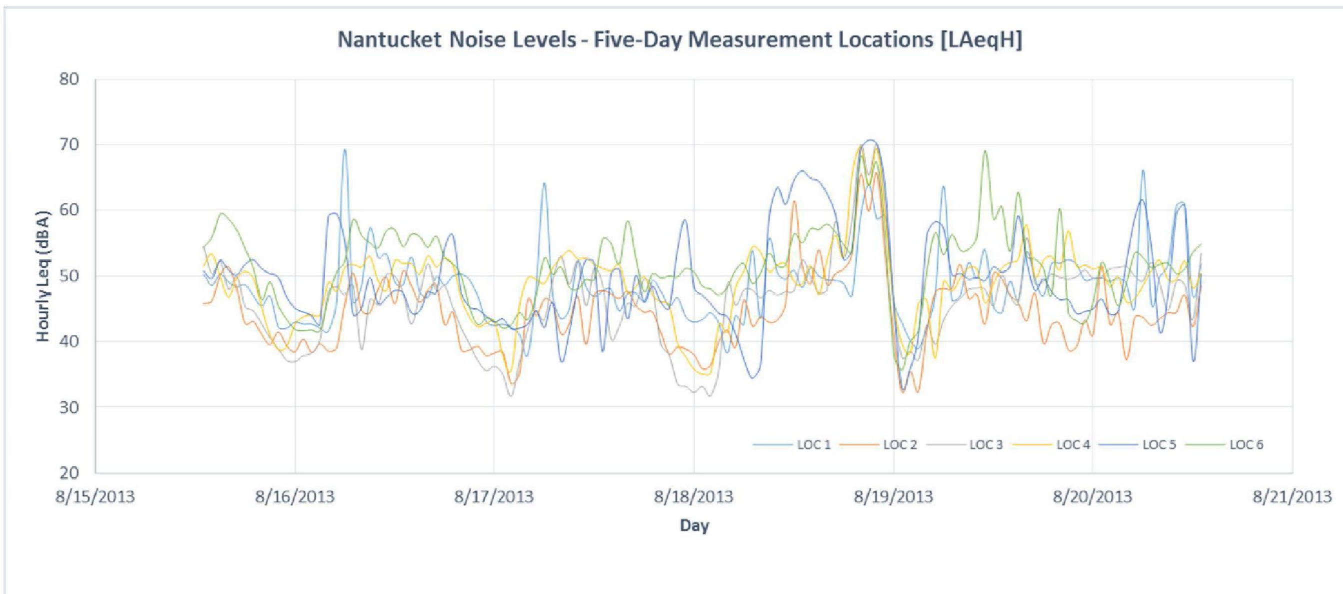



**Figure 3 Hourly Leq Noise Levels at All of the Five-Day Measurement Locations**

**Location 1 (84 Egan Lane)**

This location is approximately 2000 feet northwest of the airport. It lies in an area that is mostly residential with some commercial activity, close to Old South Road. The location has a residence and is also the site of Nantucket Wildflower Farm. During the earlier part of the measurement period, a video production featuring the property was being conducted. This location had the second highest DNL 5-day average (62 dBA). This was largely a result of four hourly periods that had particularly high levels. The first (LeqH=69 dBA) occurred at approximately 5:30 AM on 8/16, and the next (LeqH=64 dBA) occurred at approximately 5:30 AM on 8/17, another one (LeqH=64 dBA) took place at approximately 8:00 PM on 8/18, and the last (LeqH=64 dBA) at approximately 5:30 AM on 8/19. Figure 4 shows the Leq hourly noise levels at Location 1.

**Location 2 (53 West Miacomet Road)**

This location is approximately 2 miles southwest of the airport. This area is one of the more remote residential areas on the island and is near a golf course with views of the south shore. During visits to the site, turning airplane tracks were observed that at some times appeared to be almost directly overhead. The site had the lowest DNL of all the measurement locations (53 dBA). Figure 5 shows the Leq hourly noise levels at Location 2.

**Location 3 (7 Briarpatch Road)**

This location is approximately 3.5 miles northeast of the airport. This area is a residential area that also lies under some of the flight patterns for the JetBlue commercial jets. During the five-day measurement period, there was considerable new house construction activity at the site; however, the microphone location was situated as far as possible from the construction noise. The DNL at this location was in the middle range for the 5-day sites (56 dBA). Since this level was very close to that at Location 4, which is in a similar area, it can be reasoned that construction noise did not dominate the Leq noise level at this location. Figure 6 shows the Leq hourly noise levels at Location 3.

**Location 4 (180 Polpis Road)**

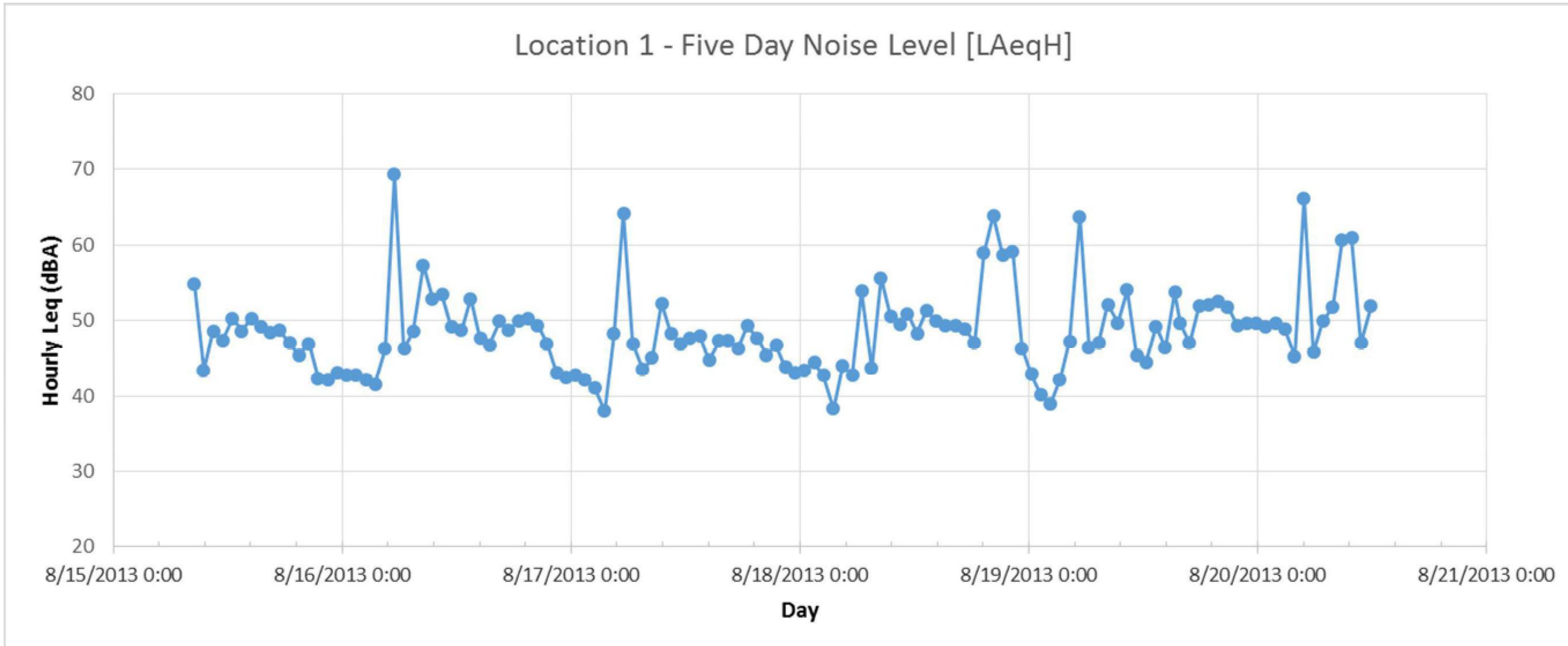
This location is approximately 2.5 miles northeast of the airport. This area is the location of a University of Massachusetts field station that is open to the public. During visits to the site, flight patterns of some of the smaller aircraft that use the airport were observed in a direction northwest from the measurement location. The DNL at this location was in the middle range for the 5-day sites (57 dBA). Figure 7 shows the Leq hourly noise levels at Location 4.

**Location 5 (18 Waiquoit Road)**

This location is approximately 3000 feet southeast of the airport. This area is a sparse residential area that is close to the south coast of the island. During visits to the site, flight patterns of some of the smaller aircraft that use the airport were observed in a direction northwest from the measurement location. On windier days, the noise level from the surf was quite prominent. The DNL at this location was the greatest of the 5-day sites (63 dBA). This was partly due to some higher level periods (approaching LAeqH=60 dBA) that occurred at early morning or nighttime hours. Figure 8 shows the Leq hourly noise levels at Location 5.

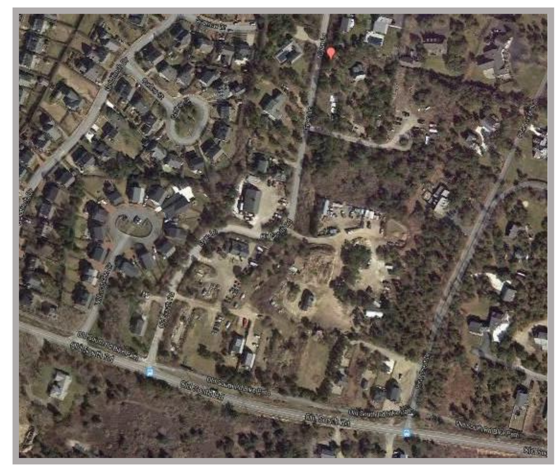
**Location 6 (35 Nobadeer Avenue)**

This location is approximately 1 mile southwest of the airport. This area is a beach community residential area that is close to the south coast of the island. During visits to the site, flight patterns of some of the aircraft that use the airport were observed occasionally directly overhead. The DNL at this location was in the higher range of the 5-day sites (59 dBA). Figure 9 shows the Leq hourly noise levels at Location 6.



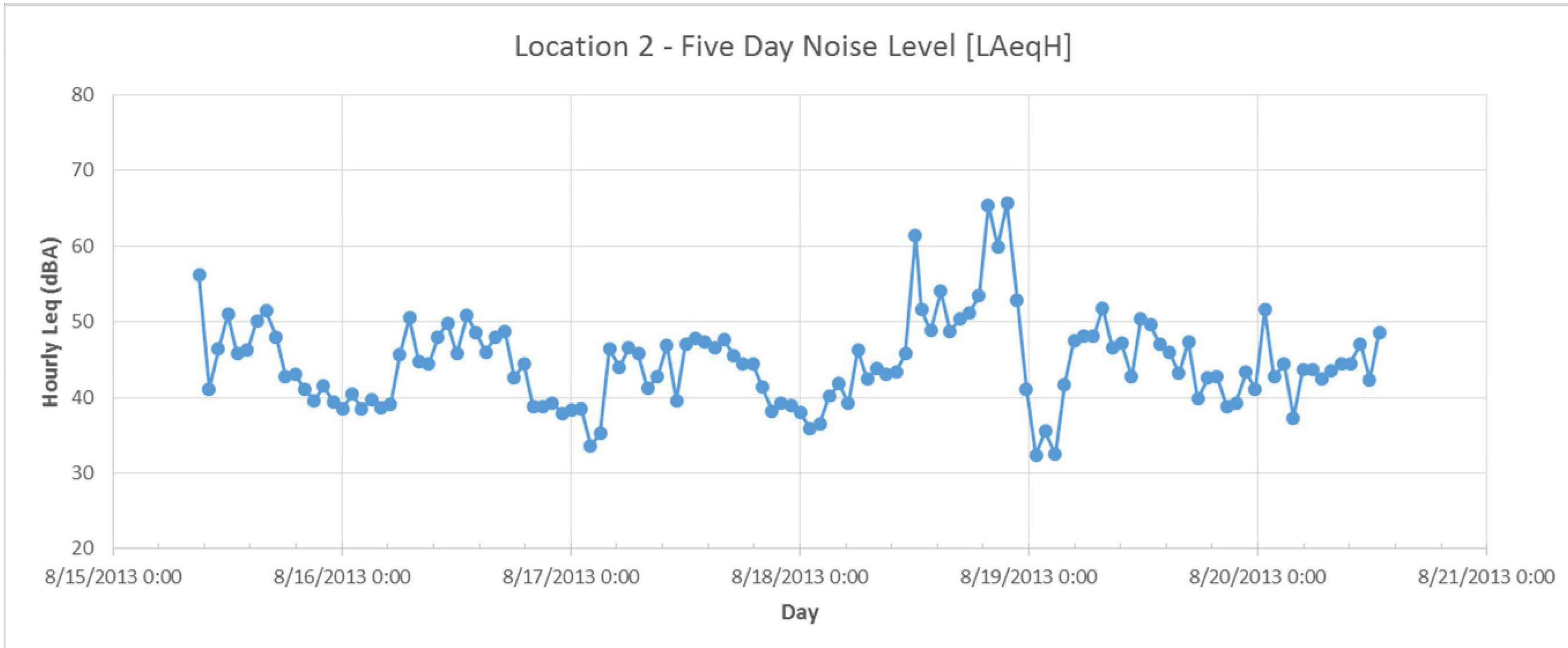

VIEW OF SITE LOOKING FROM EGEN LANE

CLOSE VIEW OF MIC LOCATION



AERIAL VIEW

**Figure 4  Location 1 Hourly Leq Noise Levels**

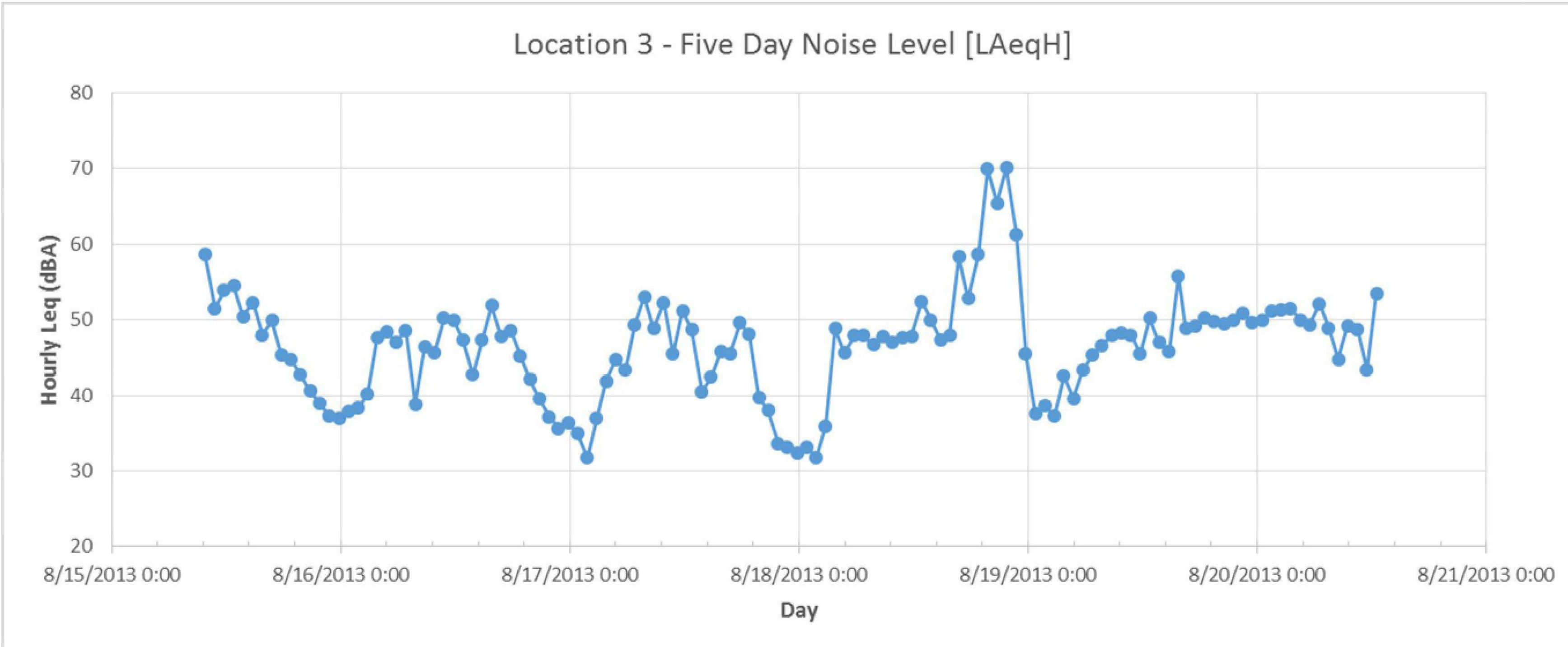



VIEW OF SITE LOOKING NORTH

CLOSE VIEW OF MIC LOCATION

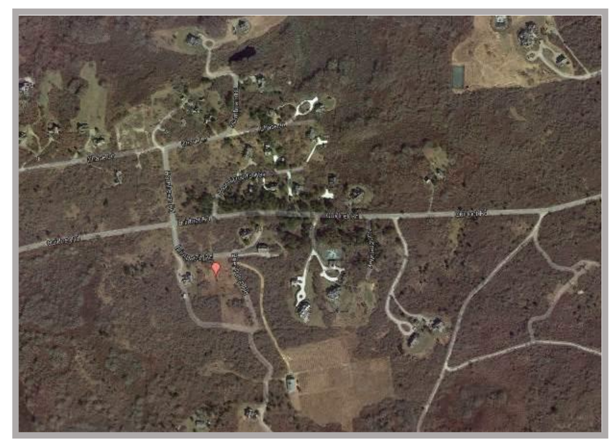
AERIAL VIEW

**Figure 5 Location 2 Hourly Leq Noise Levels**



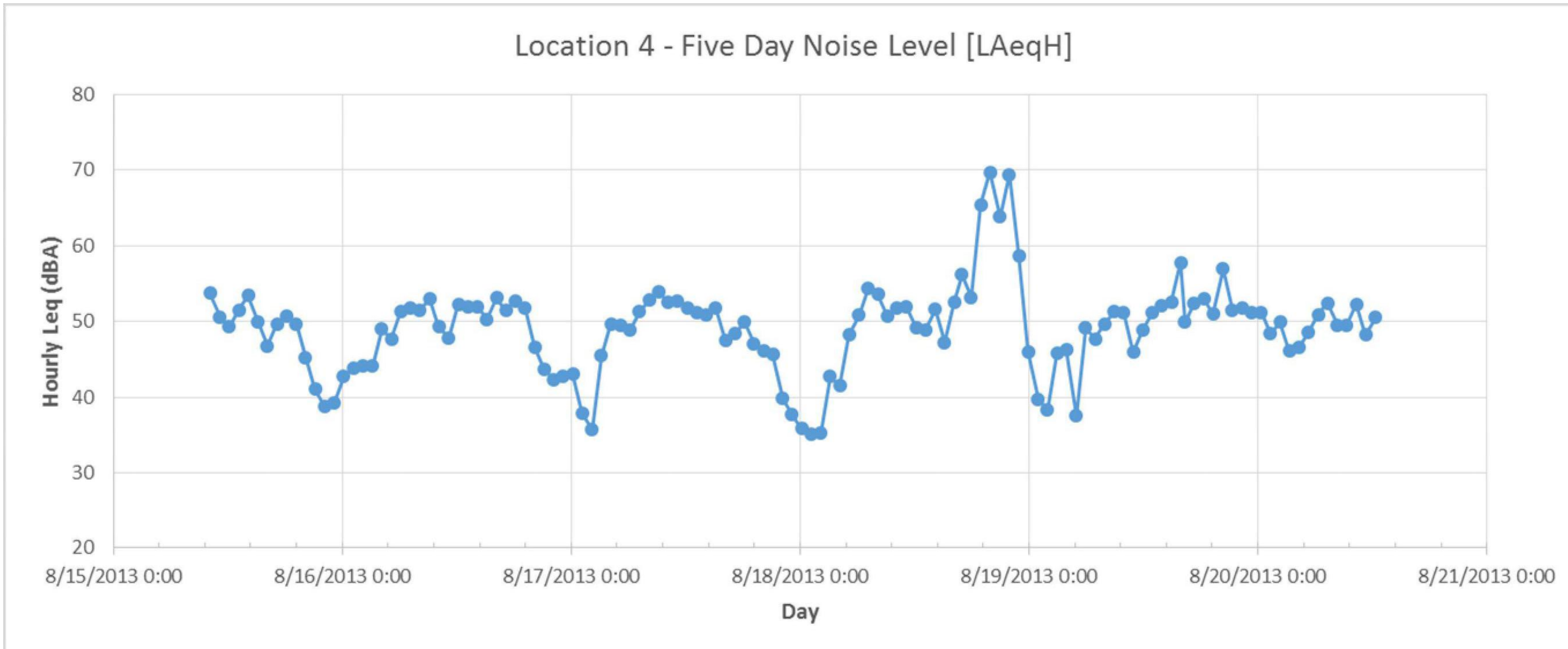

VIEW OF SITE LOOKING SOUTH

CLOSE VIEW OF MIC LOCATION



AERIAL VIEW

**Figure 6 Location 3 Hourly Leq Noise Levels**

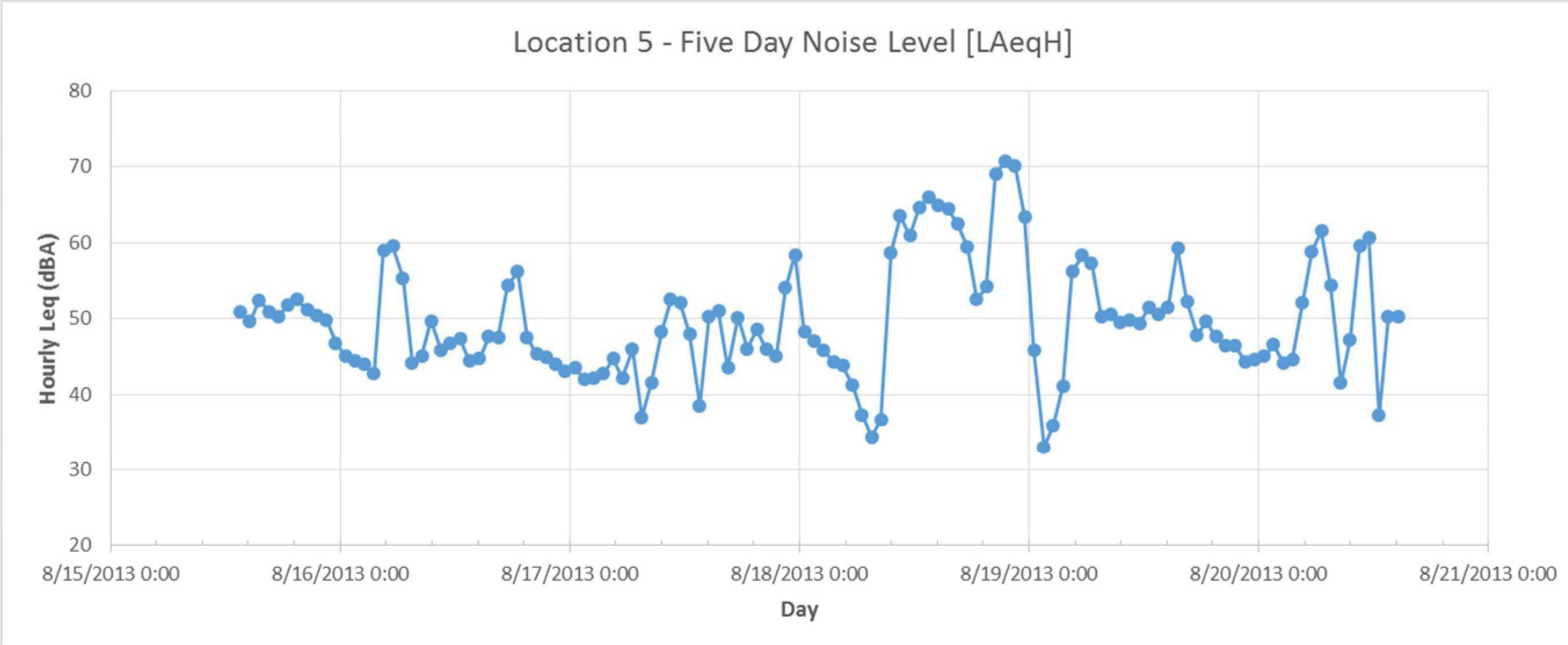



VIEW OF SITE LOOKING NORTH

CLOSE VIEW OF MIC LOCATION

AERIAL VIEW

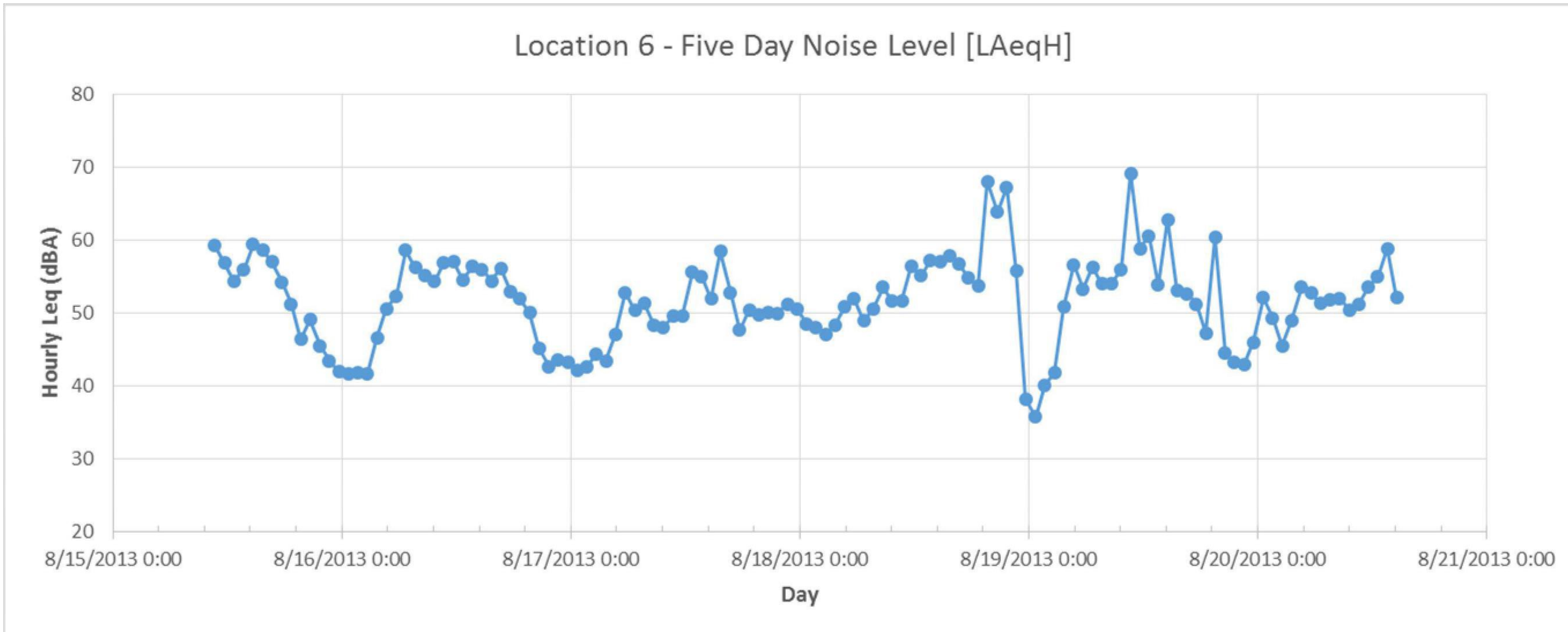
**Figure 7  Location 4 Hourly Leq Noise Levels**




CLOSE VIEW OF MIC LOCATION

AERIAL VIEW

**Figure 8 Location 5 Hourly Leq Noise Levels**




CLOSE VIEW OF MIC LOCATION

AERIAL VIEW

**Figure 9  Location 6 Hourly Leq Noise Levels**

## TWO-DAY HOURLY Leq MEASUREMENTS

Two locations were selected that were similar to those used in our previous noise measurement programs at Nantucket Airport in 2011 and 2012. For various reasons, it was not possible to duplicate the conditions that were present in the previous years. Locations 7 and 8 are shown in Figure 1.

The results of the noise monitoring at these locations are shown in Table 3, which includes the two-day average Leq, DNL, Lmax, and Lmin (for technical reasons, the sound level meters at these locations were not able to record the L10 and L90 levels).

The noise levels at these locations were somewhat higher in general than those at the 5-day locations. Location 7, at 51 Okarwaw Avenue, was closer to the airport than any of the 5-day locations, and also was subject to noise from construction activity (note the LeqH=74 dBA in Figure 10). Location 8 was just at the southwest airport property fence, and includes noise from airport ground operations (note the LeqH=72 dBA in Figure 11), as well as fairly regular traffic on Monohansett Road.

**Table 3 Two-Day Average Measurement Results**

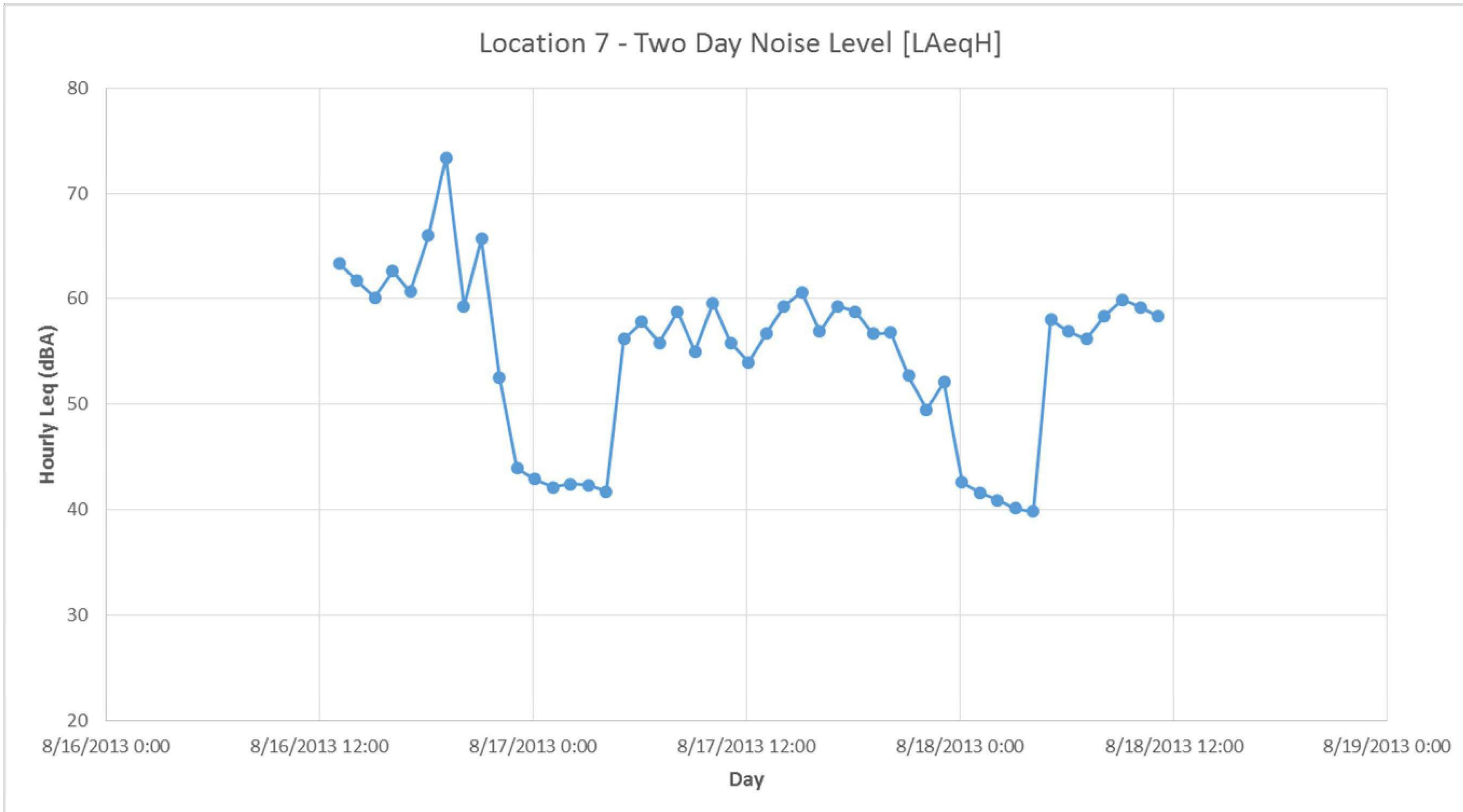
| Measurement Location | **Leq** (dBA) | **DNL** (dBA) | **Lmax** (dBA) | **Lmin** (dBA) |
|---|---|---|---|---|
| 7 | 60.5 | 62.2 | 86.4 | 38.4 |
| 8 | 63.8 | 66.9 | 86.8 | 44.2 |

For comparison purposes, the results from the 2012 Measurement program are shown in Table 4. However, it should be kept in mind that, as explained earlier, the conditions were different for the 2013 measurements such that higher levels were expected for the 2013 measurements. The higher levels shown for 2013 mostly likely do not indicate higher noise levels generated by airport operations.

**Table 4 One-Day Average Measurement Results from 2012**

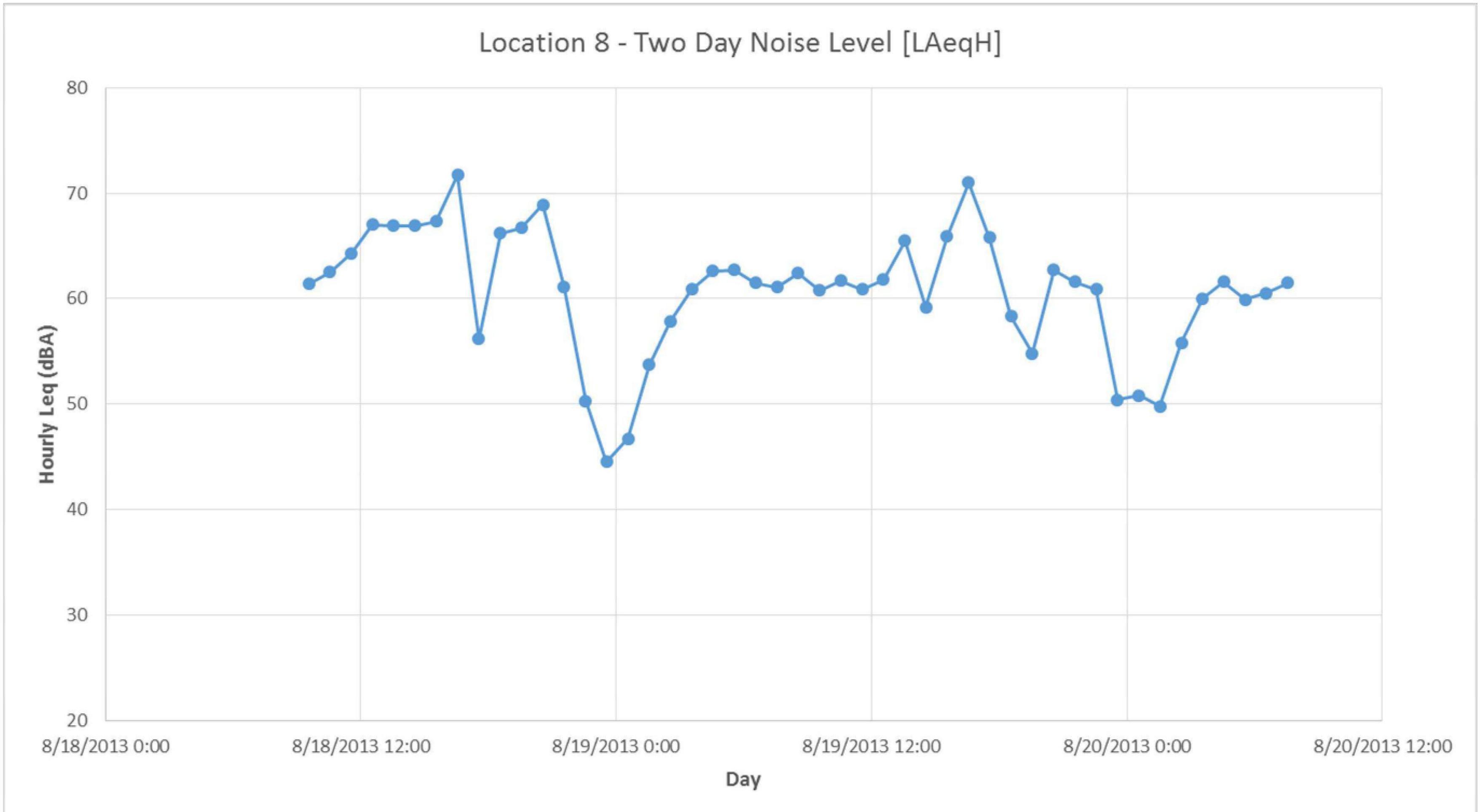
| Measurement Location | **Leq** (dBA) | **DNL** (dBA) | **Lmax** (dBA) | **Lmin** (dBA) |
|---|---|---|---|---|
| 2 [2012] | 59.6 | 60.5 | 84.4 | 38.3 |
| 1 [2012] | 59.3 | 58.7 | 82.1 | 41.8 |

Note: Location 2 [2012] = Location 7 [2013] with construction activity; Location 1 [2012] was further from the airport on private property compared to Location 8 [2013]




AERIAL VIEW

**Figure 10  Location 7 Hourly Leq Noise Levels**





CLOSE VIEW OF MIC LOCATION


AERIAL VIEW

**Figure 11 Location 8 Hourly Leq Noise Levels**

## SINGLE EVENT ACTIVITY

On the afternoon of August 15, 2013, noise measurements were obtained on the airport property near the main apron area. The location was approximately 1800 feet from the Runway 6/24 as shown in Figure 12.

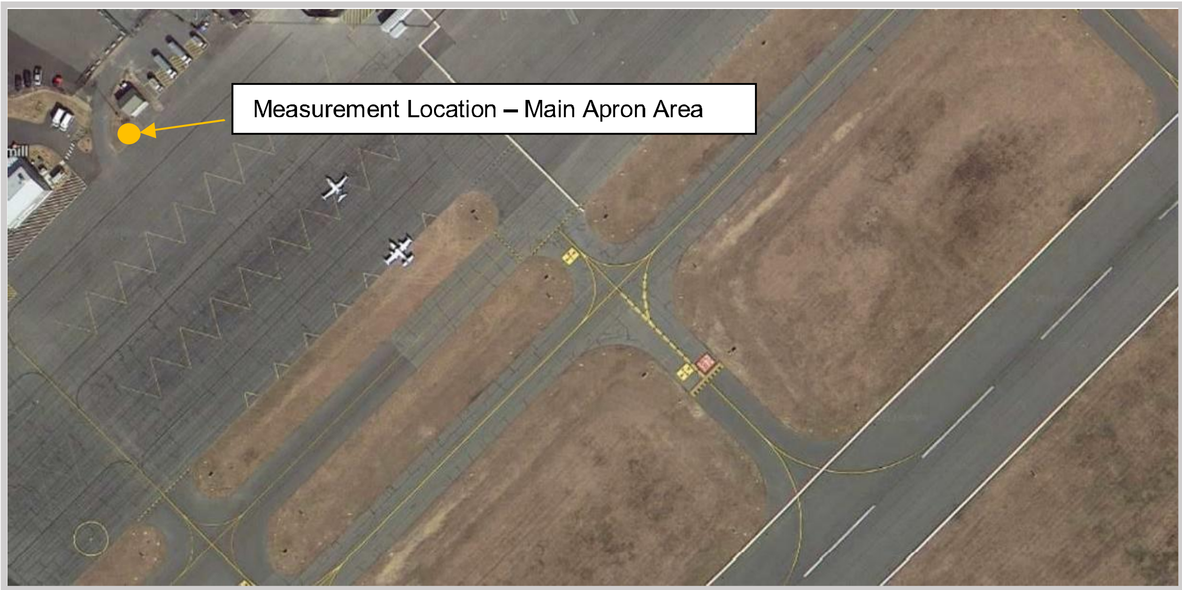



**Figure 12 Airport Property Ground Operations Measurement Location**

The purpose of these measurements was to obtain noise levels for various aircraft ground operations in the main apron area, including take-offs and landings on Runway 6/24. The measurement system recorded a time history of 1 second Leq noise levels for several 20-minute periods. This data was reduced to obtain A-weighted Leq levels for each second (LAeq[1sec]). The results for several 20-minute periods are shown in Figures 13-20. Each figure is followed by a figure showing some details from the 20-minute period.

As the figures show, noise levels were typically quite high from approximately 75 dBA for general aircraft idling and service truck activity to over 90 dBA from nearby taxing and APU standby operations from GA jet aircraft. Although not shown in the figure, for a small percentage of time, the background level would drop to about 54 dBA, which is approximately the level of the HVAC units for the adjacent administration/maintenance building. Note that the elapsed time shown in the figures is relative to the start time of the measurement (4:08 PM).

Similar noise measurements were obtained in 2011 and 2012. The Lmax noise levels from the APUs are approximately the same for the noise measurements obtained for each of the three years resulting in a relatively high hourly Leq noise levels of approximately 80 dBA at this measurement location from aircraft ground operations in the main apron area. The measured hourly Leq noise levels are a function of the distance, the number, and the duration of the GA jet aircraft ground operations that occur within the apron area during the measurement period.

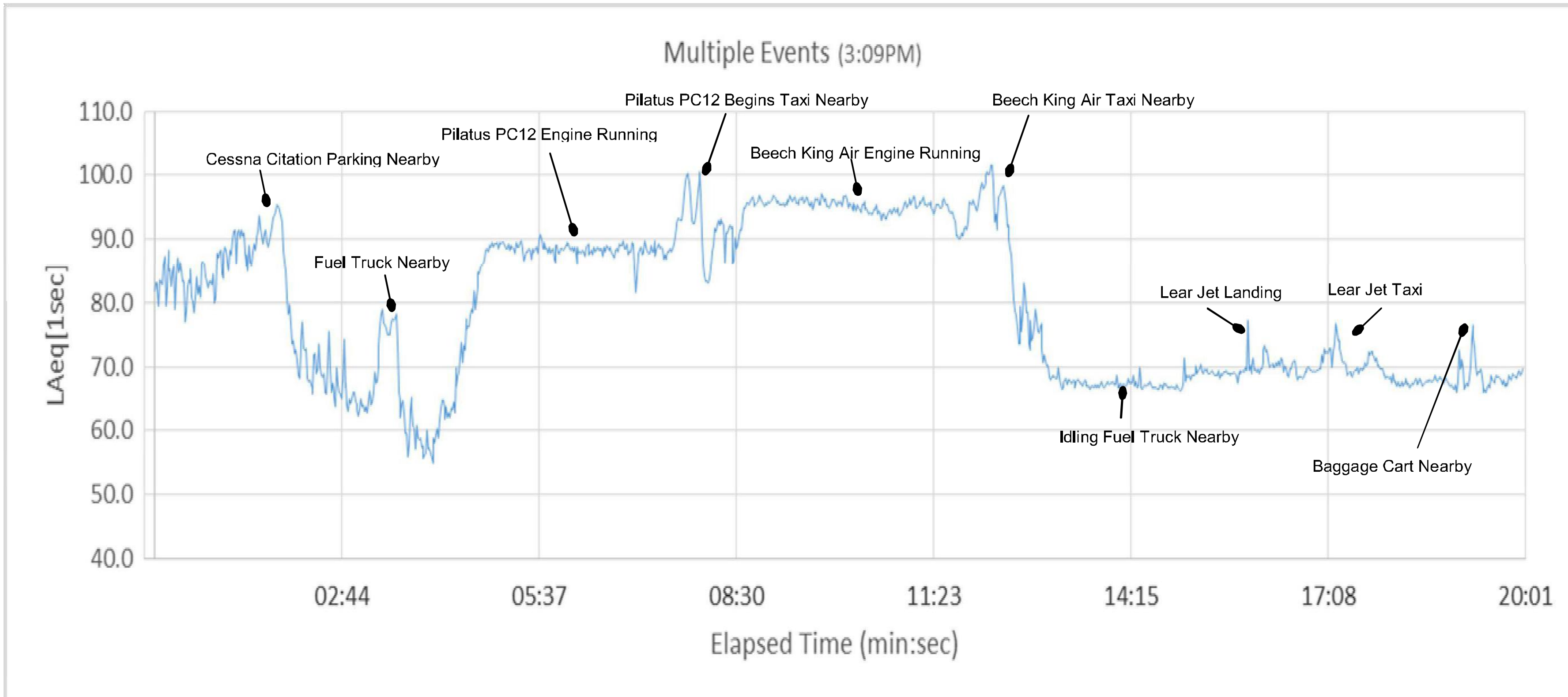



**Figure 13  Airport Noise Levels Time History Beginning 3:09 PM**

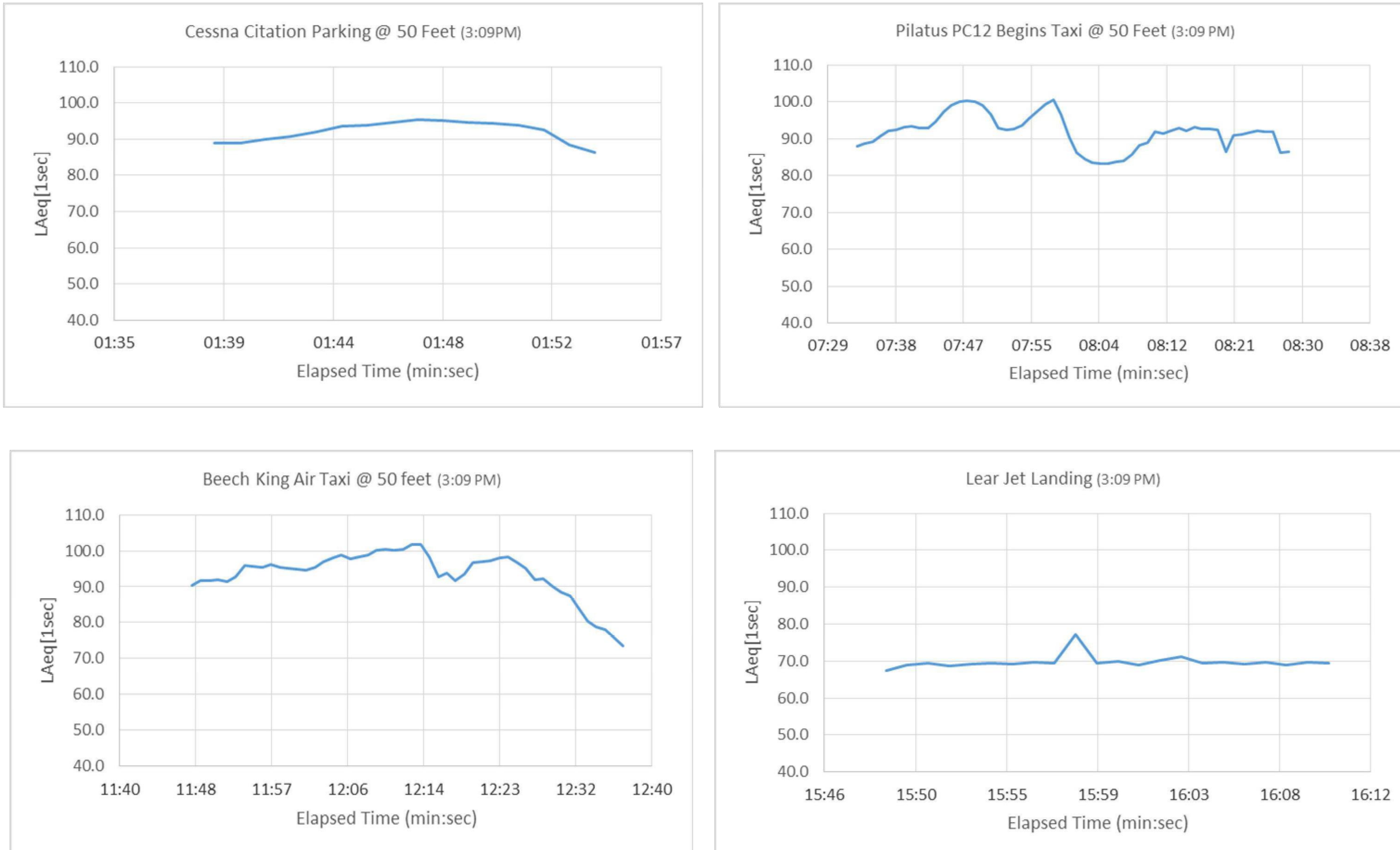



**Figure 14  Airport Noise Levels -  Selected Events Beginning 3:09 PM**

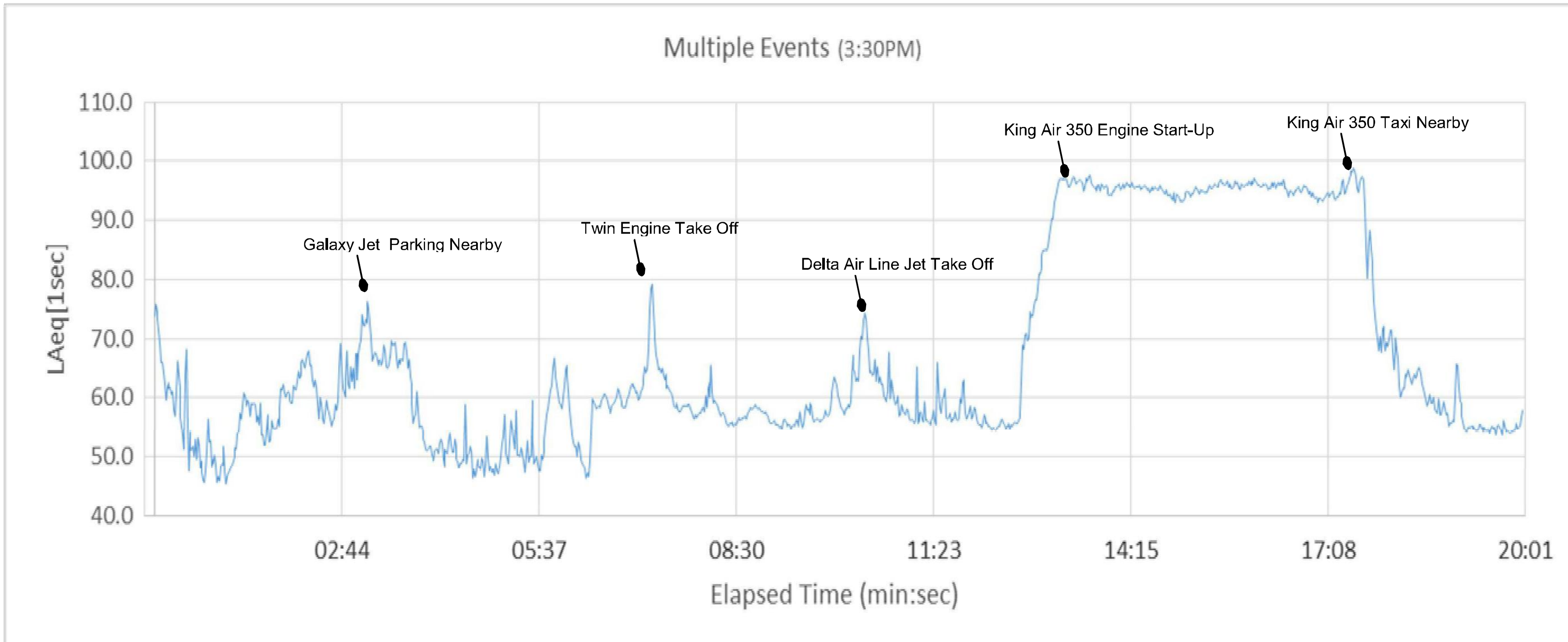
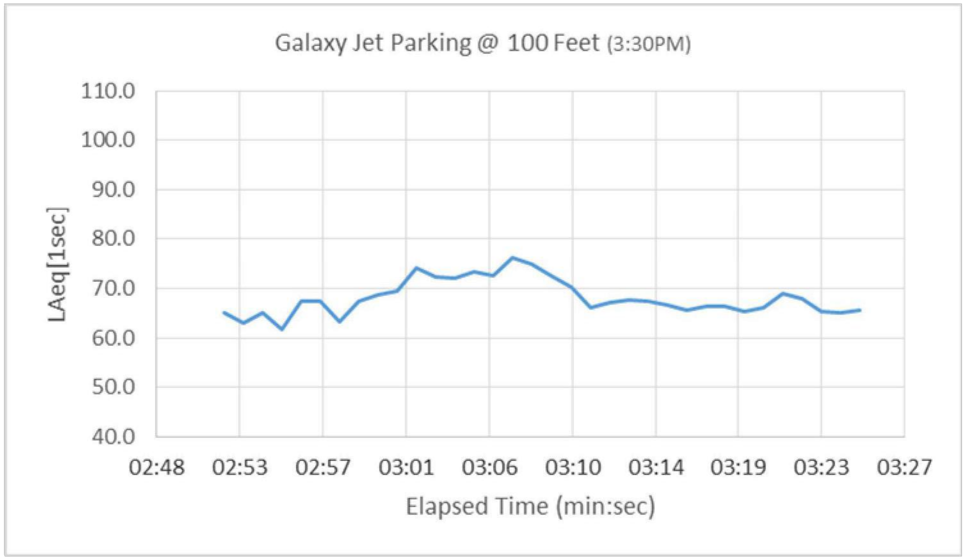
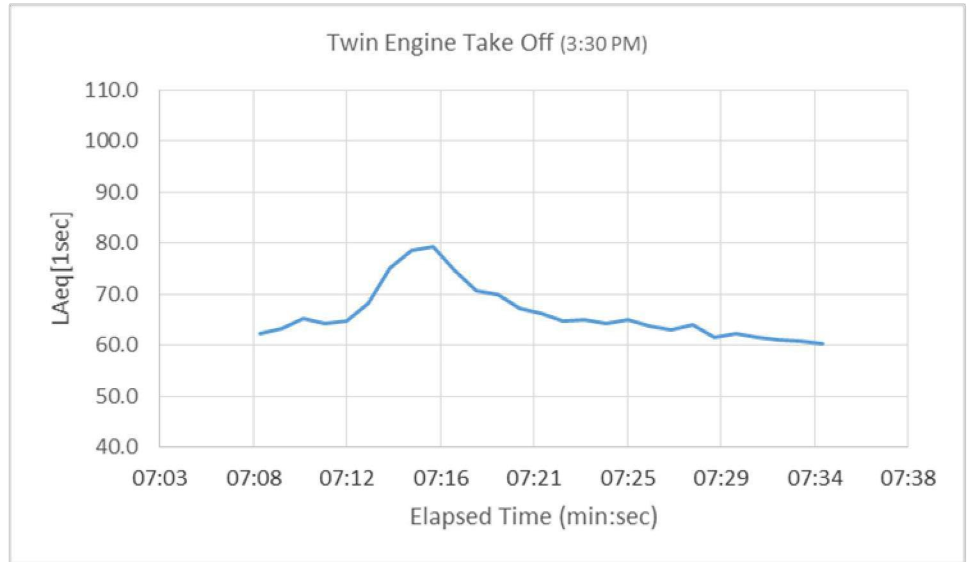
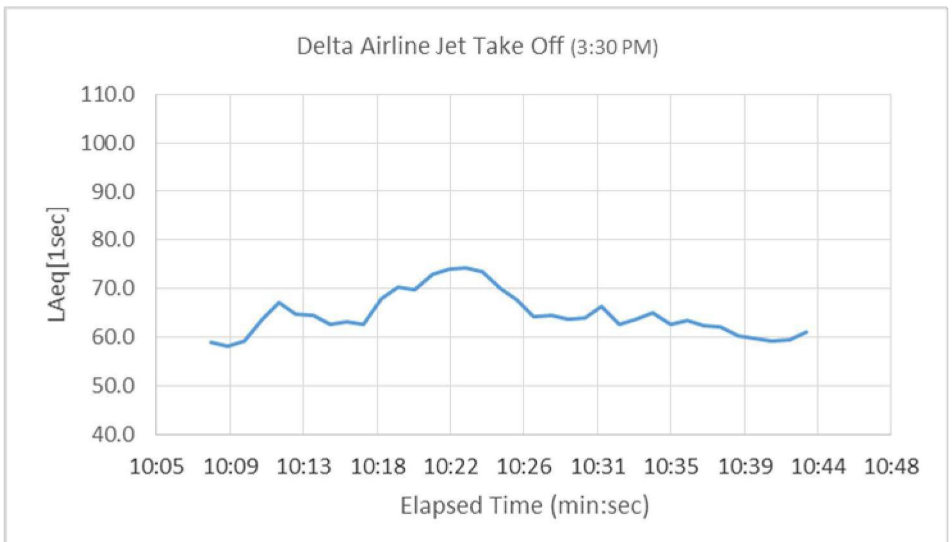



**Figure 15 Airport Noise Levels Time History Beginning 3:30 PM**



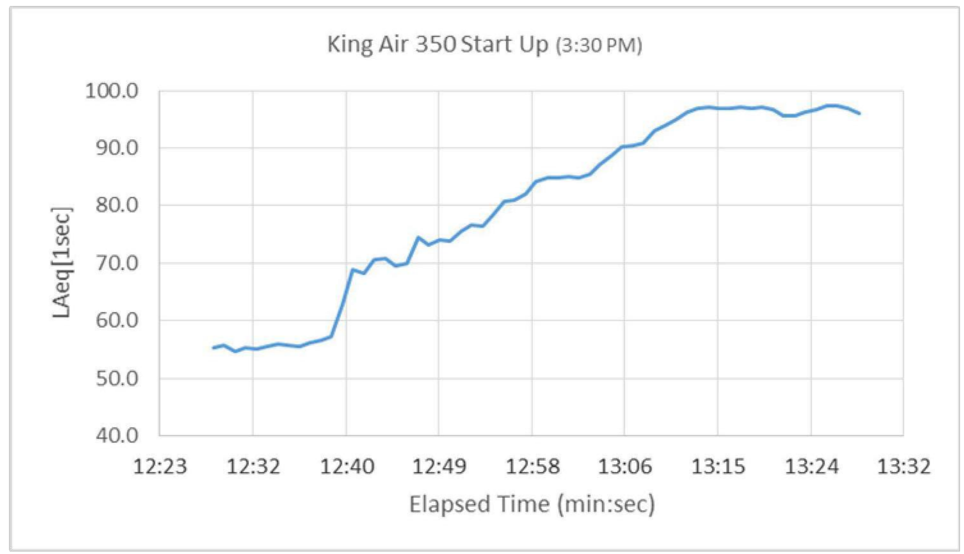




**Figure 16 Airport Noise Levels - Selected Events Beginning 3:30 PM**

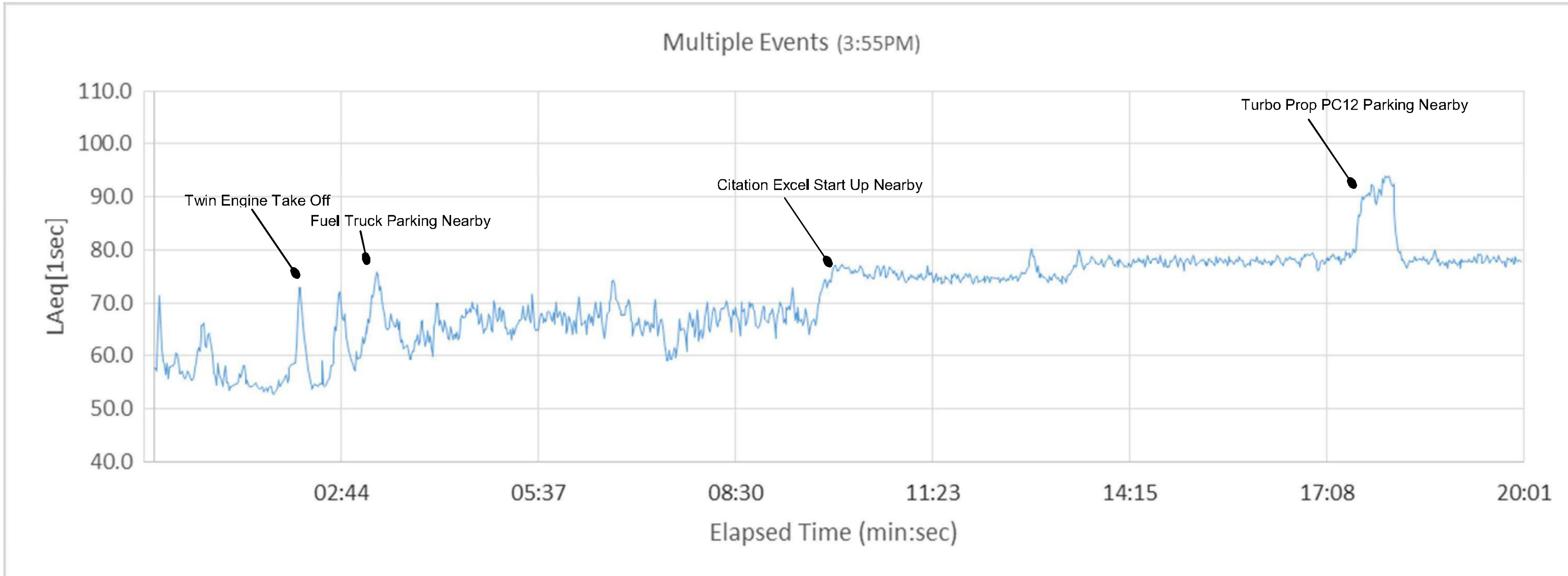



**Figure 17  Airport Noise Levels Time History Beginning 3:55 PM**


**Figure 18 Airport Noise Levels - Selected Events Beginning 3:55 PM**

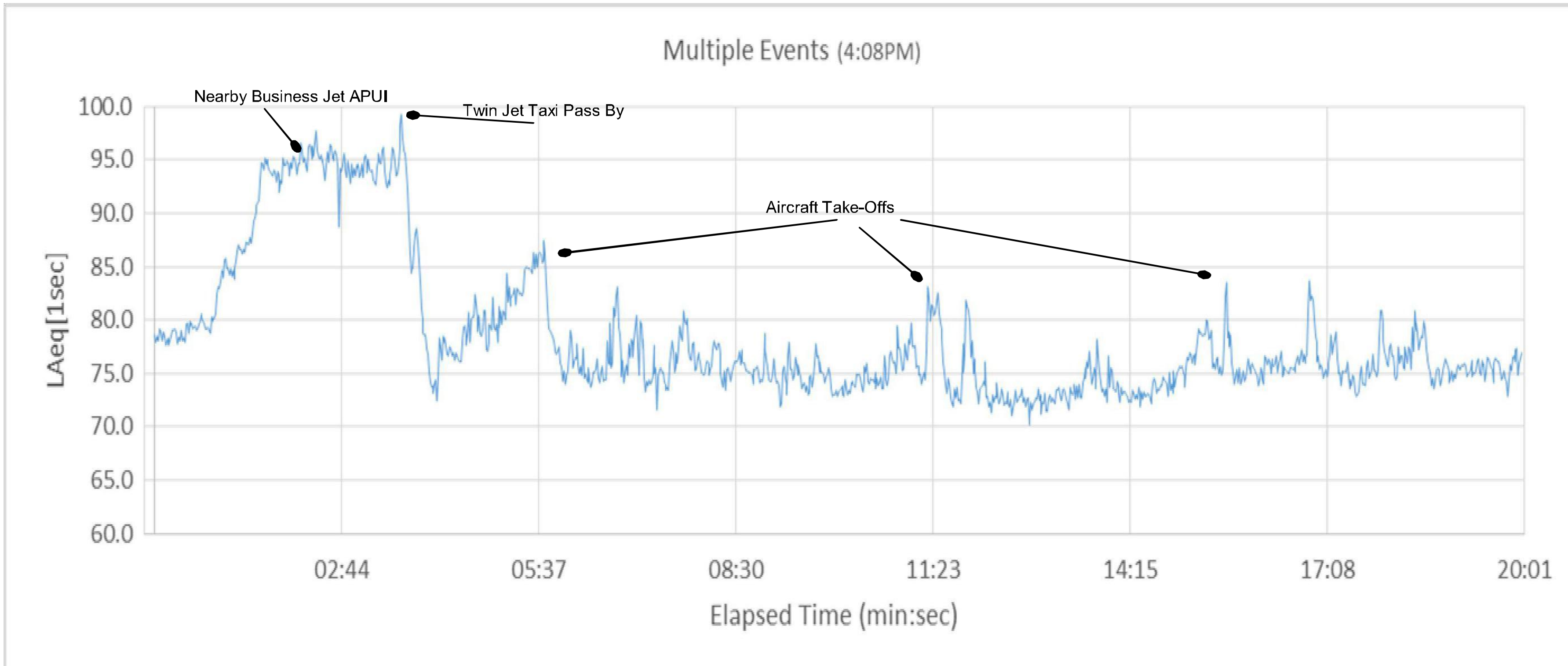



**Figure 19 Airport Noise Levels Time History Beginning 4:08 PM**

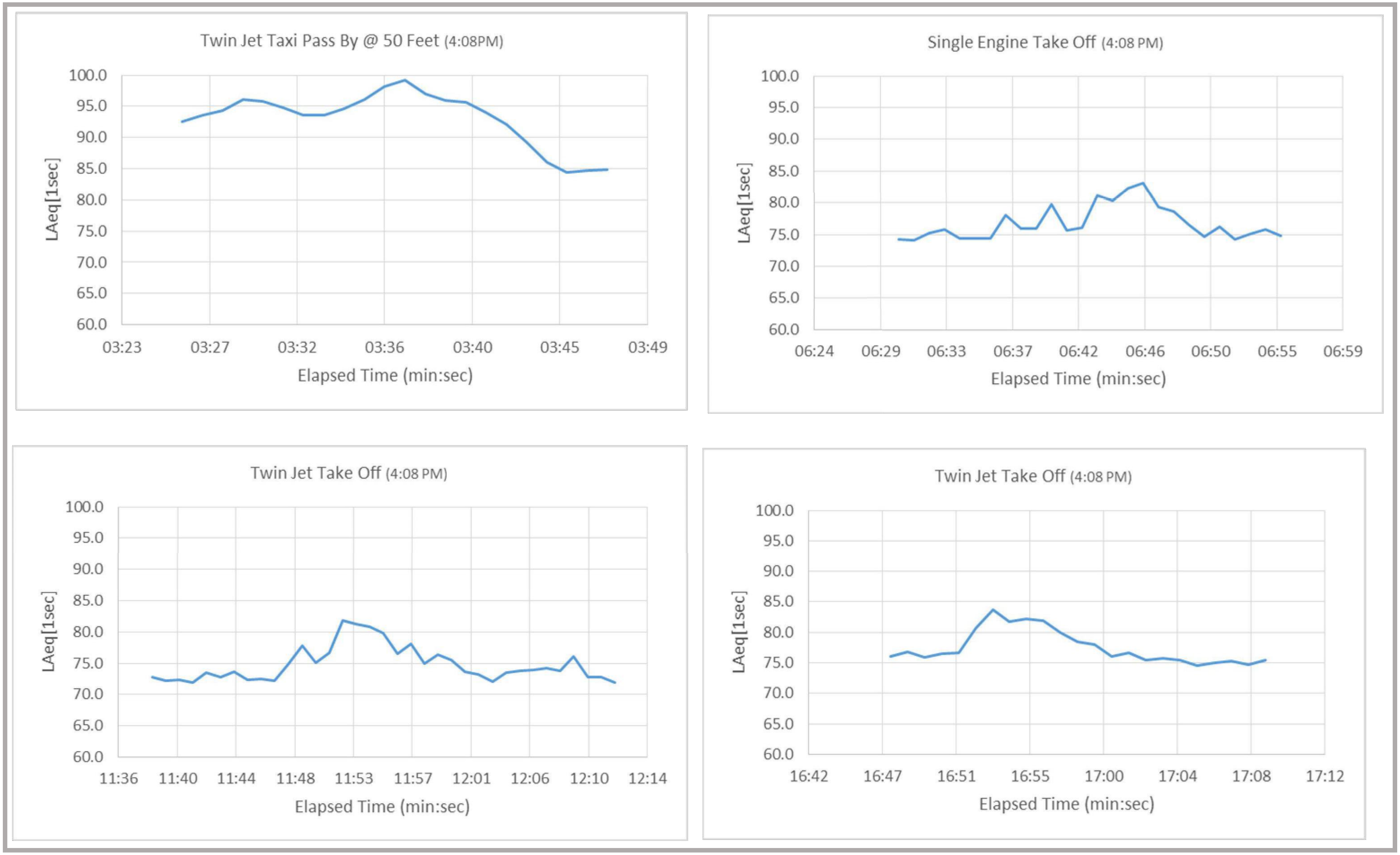



**Figure 20 Airport Noise Levels - Selected Events**

# Nantucket Memorial Airport

## South Apron Extension
## - August 2012 Noise Measurements and Noise Mitigation Assessment

**September 2012**

**Prepared by:**
**KM Chng Environmental Inc.**
**Woburn, MA 01801**

## Introduction

KM Chng Environmental Inc. (KM Chng) performed a follow-up noise measurement study at Nantucket Memorial Airport for comparison with the noise measurements that were obtained in August 2011. As in the 2011 noise study, 24-hour noise measurements were obtained at the same two residences shown in Figure 1 to determine the current noise levels near the proposed South Apron extension. Both of these locations represent the residences closest to the proposed South Apron extension. Measurement Location 1 is the residence at 51 Okorwaw Avenue, and measurement Location 2 is the residence at 31 Monohansett Road. These 24-hour noise measurements consisted of hourly Leq(h) noise levels that were then used to determine the existing DNL noise levels. The noise measurements obtained at these two locations included the noise from aircraft operations at the airport, especially from aircraft takeoff and landing operation on Runway 6/24. Noise measurements were obtained using two Rion NL-32 sound level meters that meet ANSI Standards for Type I accuracy and quality.

In addition, short-term noise measurements similar to those obtained in 2011 were also obtained at the existing apron area to determine the noise levels from aircraft start-up, idle, and taxi ground operations. These aircraft ground operations are similar to those that are expected to occur within the South Apron extension area. Hourly time histories were obtained that show the measured Lmax noise levels in 1-second time intervals. The primary purpose of these noise measurements is to evaluate the effectiveness of the 'voluntary policy' on restricting the use of aircraft APU's in the apron area (see Attachment A).

This report also includes a noise assessment of potential mitigation measures to reduce the noise from aircraft ground operations in the South Apron extension area. These noise mitigation measures included a noise wall, earth berm, or aircraft hangers that would be located along the property line of the airport to reduce the noise levels at the nearby residences. This noise assessment evaluated the effectiveness of different barrier heights in reducing the noise from aircraft ground operations.


**Figure 1: Proposed Area of South Apron Extension and Nearest Noise Sensitive Receptors**

## Noise Metrics

Noise is "unwanted sound" and, by this very definition, the perception of noise is a subjective process. Several factors affect the actual level and quality of sound (or noise) as perceived by the human ear and can generally be described in terms of loudness, pitch (or frequency), and time variation.

<u>*Loudness.*</u> The loudness, or magnitude, of noise determines its intensity and is measured in decibels (dB). The noise decibel is used to describe a large range of sound levels. For example, ambient noise ranges from 40 decibels from the rustling of leaves to over 70 decibels from a truck passby to over 100 decibels from a rock concert.

*Pitch.* Pitch describes the character and frequency content of noise. Measured in Hertz (Hz), frequency is typically used to identify the annoying characteristics of noise and thereby identify the proper mitigation to help eliminate or minimize its magnitude. The human ear is typically sensitive to noise frequencies between 20 Hz (low-pitched noise) and 20,000 Hz (high-pitched noise). For example, noise may range from very low-pitched "rumbling" noise from stereo sub-woofers to mid-range traffic noise to very high-pitched whistle noise.

*Time Variation.* The time variation of some noise sources can be characterized as continuous, such as a building ventilation fan, intermittent, such as for an aircraft flyover, or impulsive, like a car backfire.

Various levels are used to quantify noise from aircraft operations including a sound's loudness, duration, and tonal character. For example, the A-weighted decibel (dBA) is commonly used to describe the overall noise level. Because the decibel is based on a logarithmic scale, a 10-decibel increase in noise level is generally perceived as a doubling of loudness, while a 3-decibel increase in noise is just barely perceptible to the human ear. The A-weighting is an attempt to take into account the human ear's response to audible frequencies. The following A-weighted noise descriptors are typically used to determine impacts from aircraft operations:

- Lmax represents the maximum noise level that occurs during an event or aircraft operation and is the noise level actually heard during the event or flyover.
- Leq represents a level of constant noise with the same acoustical energy as the fluctuating noise levels observed during a given interval such as one hour. Leq(h) is a noise level averaged over a one hour time period.
- DNL, the day-night noise level, represents the average noise level evaluated over a 24-hour period. A 10-decibel penalty is added to events that occur during the nighttime hours (10:00 PM to 7:00 AM) to account for people's increased sensitivity to noise while they are sleeping. For airport projects the DNL level is commonly used to describe noise at residences.

**Noise Measurement Results**

Noise measurements were obtained at Nantucket Memorial Airport during the weekend of August 24th in an effort to measure airport noise levels during a typical busy summer weekend. Short-term noise measurements were obtained on airport property near the main apron area. In addition, 24-hour noise measurements were also obtained at the two residences located adjacent to the area of the proposed South Apron extension. The following describes the results of the noise measurements obtained at Nantucket Memorial Airport.

<u>24-Hour Noise Measurements</u>

Noise measurements were obtained over a 24-hour period at two residences located adjacent to the proposed South Apron extension. Measurement Location 1 is located at the residence at 51 Okorwaw Avenue. This residence is located approximately 575 feet from the taxiway, 980 feet from Runway 6/24, and 1,200 feet from the end of Runway 6 where the aircraft start their takeoff. Measurement Location 2 is located at 31 Monohansett Road. This residence is also located approximately 575 feet from the taxiway, 980 feet from Runway 6/24, and 1,600 feet from the end of Runway 6 where the aircraft start their takeoff. Figures 1 and 2 show the location of these two measurement sites.

Noise measurements were obtained at both locations over the same 24-hour time period from Friday at 11:00 AM to Saturday at 12:00 noon. Aircraft takeoff and landing operations were on Runway 24 at the start of the noise measurements. At approximately 7:00 PM, the wind direction changed, and the aircraft takeoff and landings shifted to Runway 6, which is the end of the runway closest to the two measurement locations.

Figure 3 shows the measured hourly (Leq(h) noise levels over the 24-hour period obtained at measurement Location 1. During the daytime and evening hours, the measured hourly Leq(h) noise levels ranged from 55 to 66 dBA, depending on the amount of hourly aircraft activity, primarily from GA jet aircraft. During the nighttime and early morning hours between 10:00 PM and 5:00 AM when there was no aircraft activity at the airport, the measured hourly Leq(h) noise levels ranged from 40 to 45 dBA. Adding 10-dB to the measured nighttime hourly Leq(h) noise levels between 10:00 PM and 7:00 AM resulted in a 24-hour DNL noise level of 60.5 dBA at measurement Location 1.

Figure 4 shows the measured hourly Leq(h) noise levels over a 24-hour period obtained at measurement Location 2. During the daytime and evening hours, the measured hourly Leq(h) noise levels ranged from 55 to 64 dBA, depending on the amount of hourly aircraft activity, primarily from GA jet aircraft. During the nighttime and early morning hours between 10:00 PM and 5:00 AM when there was no aircraft activity at the airport, the measured hourly Leq(h) noise levels ranged from 42 to 49 dBA. Adding 10-dB to the measured nighttime hourly Leq(h) noise levels between 10:00 PM and 7:00 AM resulted in a 24-hour DNL noise level of 59.5 dBA at measurement Location 2.


**Figure 2: Nantucket Airport – South Apron Extension Area**
**24-Hour Noise Measurement Locations**

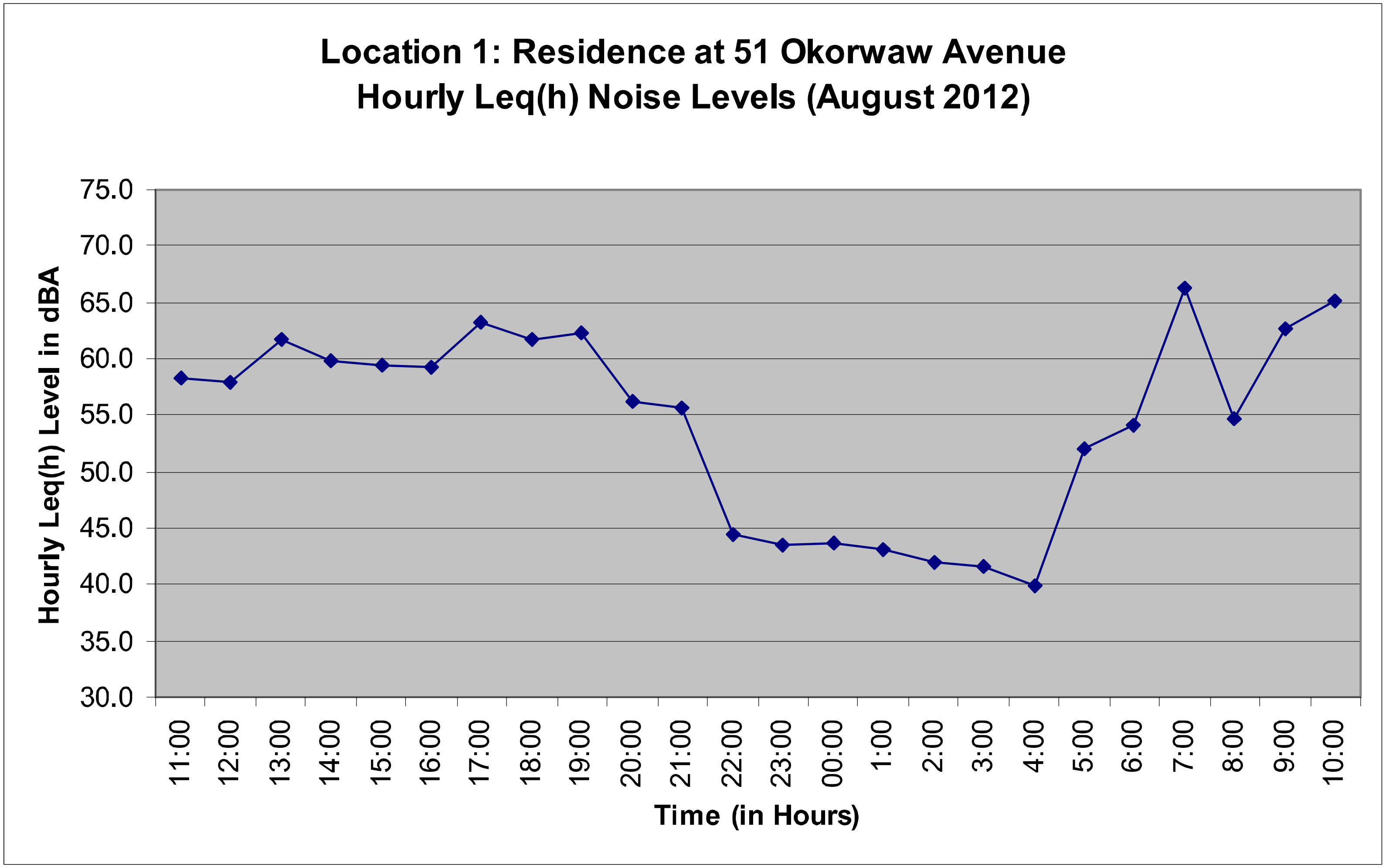



**Figure 3: Measured Hourly Leq(h) Noise Levels at Measurement Location 1 – Residence at 51 Okorwaw Avenue**

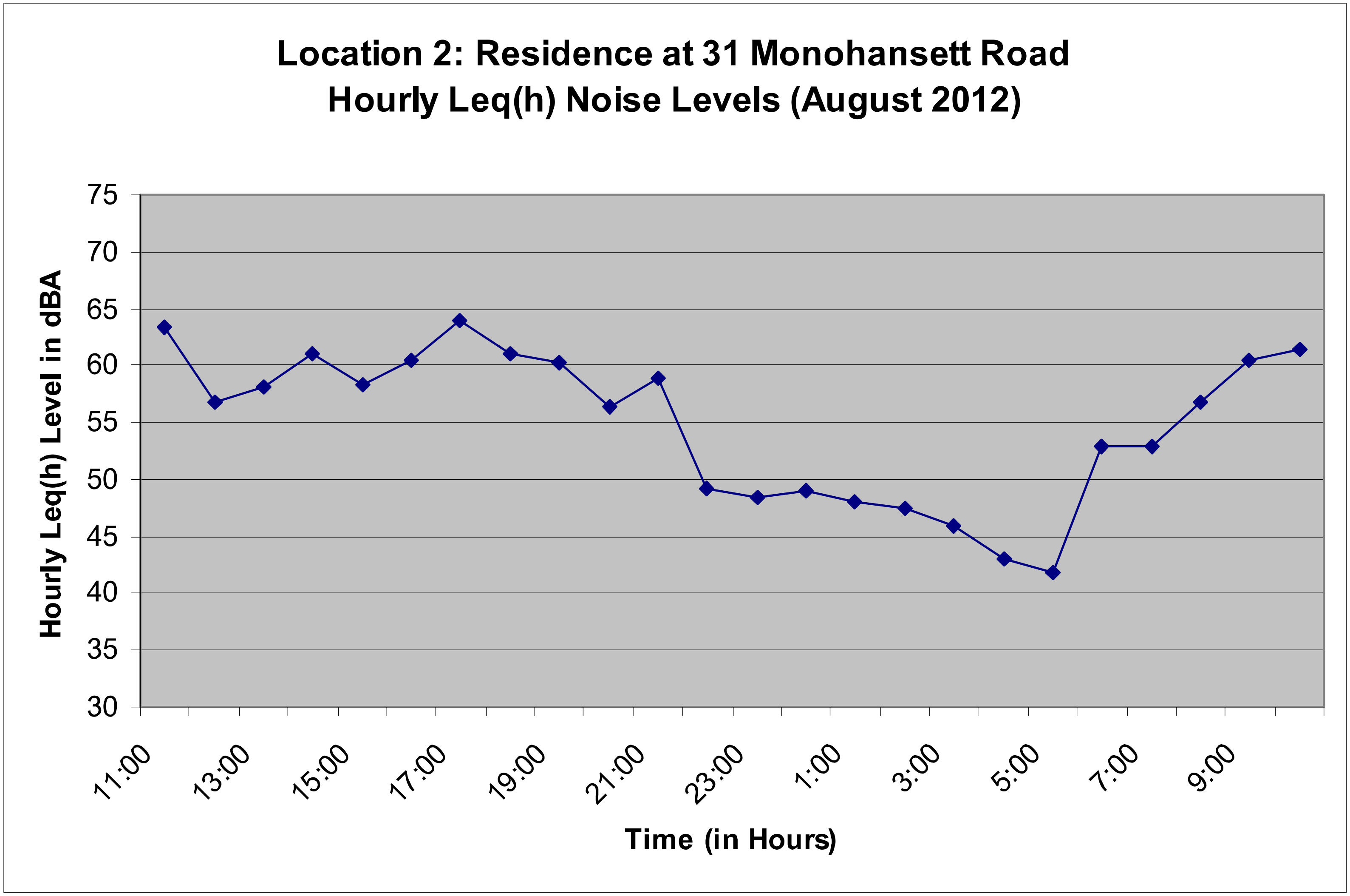



**Figure 4: Measured Hourly Leq(h) Noise Levels at Measurement Location 2 – Residence at 31 Monohansett Road**

The higher DNL noise level at measurement Location 1 (60.5 dBA versus 59.5 dBA) is probably because this location is closer to the end of Runway 6 where the aircraft sometime sit idling on the taxiway waiting for other aircraft to takeoff and land, power-up for positioning, and then run-up the engines to full power for takeoff.

Table 1 shows a comparison of the measured DNL noise levels at measurement Locations 1 and 2 obtained in 2012 with the noise measurements obtained in 2011. The DNL noise level measured at Location 1 is 1.9 dBA lower in 2012 versus 2011. The DNL noise level measured at Location 2 is 1.4 dBA lower in 2012 versus 2011. However, this decrease in the measured DNL noise levels may be due to a reduction in the amount of aircraft activity at the airport in 2012, especially in the number of GA jet aircraft operations.

**Table 1: Comparison of Measured DNL Noise Levels (2012 versus 2011)**

| | **2012 Measured DNL Level** | **2011 Measured DNL Level** | **Change** |
|---|---|---|---|
| Measurement Location 1 | 60.5 dBA | 62.4 dBA | -1.9 dBA |
| Measurement Location 2 | 59.5 dBA | 60.9 dBA | -1.4 dBA |

Aircraft Ground Operations

The second part of the noise measurement program at Nantucket Memorial Airport consisted of measuring the noise levels from aircraft ground operations similar to those that are expected to occur in the South Apron Extension area. The present plans at the Airport call for moving some of the smaller GA jet and GA single-engine and twin-engine piston aircraft operations to the South Apron Extension area during the busy summer weekends so that there would be more room in the existing South Apron area for the increasing number of GA jet aircraft to operate and maneuver at the Airport.

On Thursday August 23rd, noise measurements were obtained on airport property adjacent to the Main Apron area shown in Figure 5. These noise measurements were obtained over a one-hour period from 11:30 AM to 12:30 PM. Figure 6 shows the one-hour time history of the Lmax noise levels obtained at the Main Apron area. In addition to the noise from aircraft takeoff and landing operations on Runway 6/24 and other activity in the apron area, this figure also shows the noise from several GA jet aircraft during start-up and running of their GPUs for aircraft power and cabin air-conditioning while they idled for several minutes before engine start-up and taxiing out of the apron area for takeoff. The measured noise levels from the GA jet aircraft during GPU idle and engine start-up and taxi were approximately 87 to 92 dBA at a distance of approximately 150 feet from the aircraft. The aircraft idling on APU power ranged in duration from 2 to 4 minutes. As a result of these relatively high and constant noise levels during aircraft idle, the measured hourly Leq(h) level during this one hour time period was 80.7 dBA.

These results are similar to the noise measurements obtained in 2011 at this same measurement location. For comparison purposes, Figure 7 shows the results of the one-hour time history of the Lmax noise levels obtained in 2011. The measured noise levels from the GA jet aircraft during GPU start-up and running during idle were approximately 87 to 90 dBA at a distance of 150 feet from the aircraft. These noise levels lasted for approximately 4-minutes (Cessna Citation) and 8-minutes (Learjet), respectively. As a result of these relatively high and long duration constant noise levels, the measured hourly Leq(h) level during this one hour time period was 79.8 dBA.

Although the Lmax noise levels from the APUs are approximately the same for the 2012 and 2011 data, the duration of the idling time for each aircraft appears to be reduced. In 2011, the measurement results indicate that the duration time for aircraft idling ranged from 4 to 8 minutes. In 2012, the duration time for the aircraft idling ranged from 2 to 4 minutes while in the apron area. However, the overall measured hourly Leq(h) noise level is a function of the number and the duration of GA jet aircraft operations that occur within the apron area during the hourly measurement period.


**Figure 5: Nantucket Airport On-Site Measurement Location – Main Apron Area**

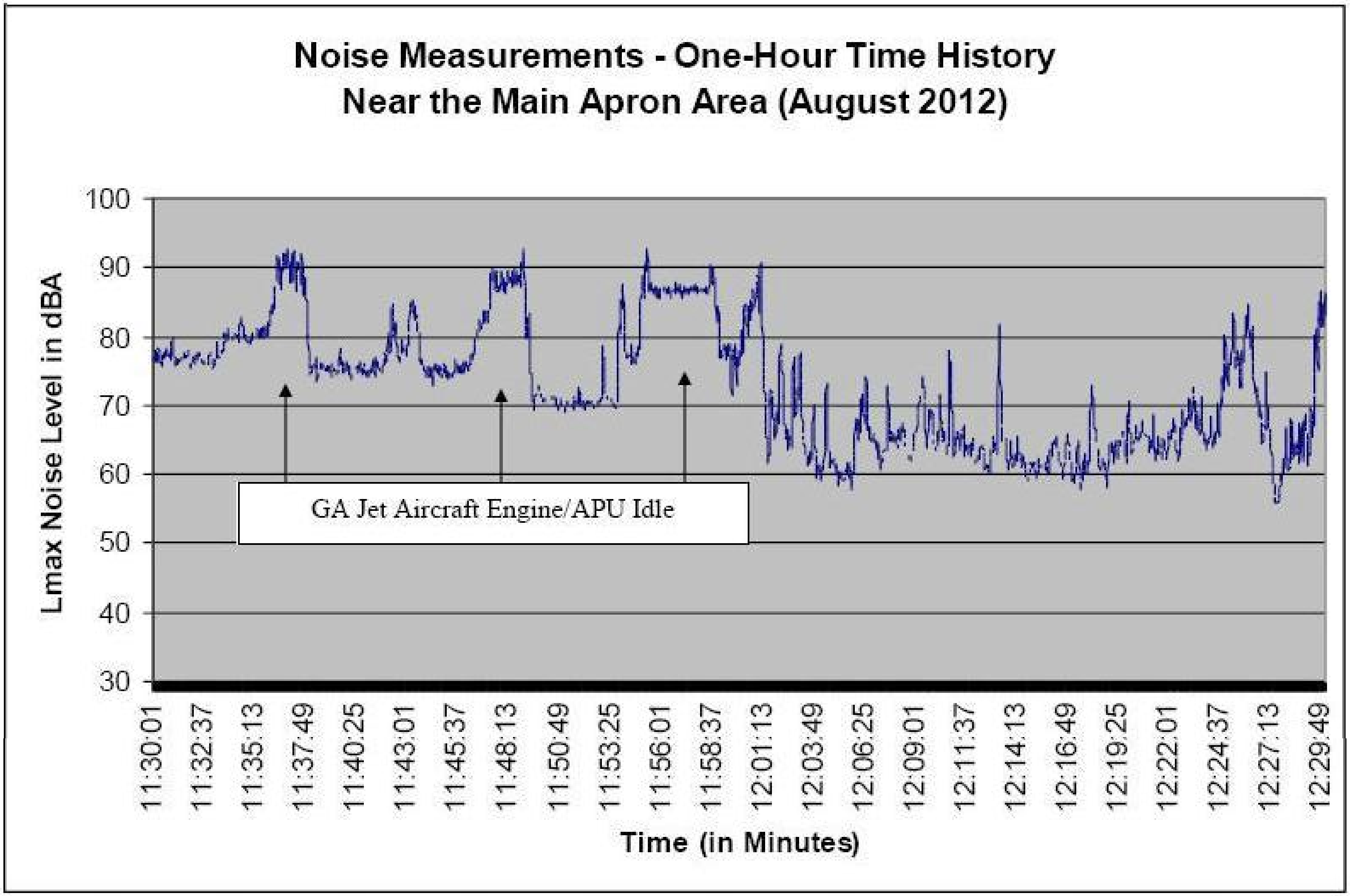



**Figure 6: One-Hour Time History of Lmax Noise Levels Obtained Near the Main Apron Area**

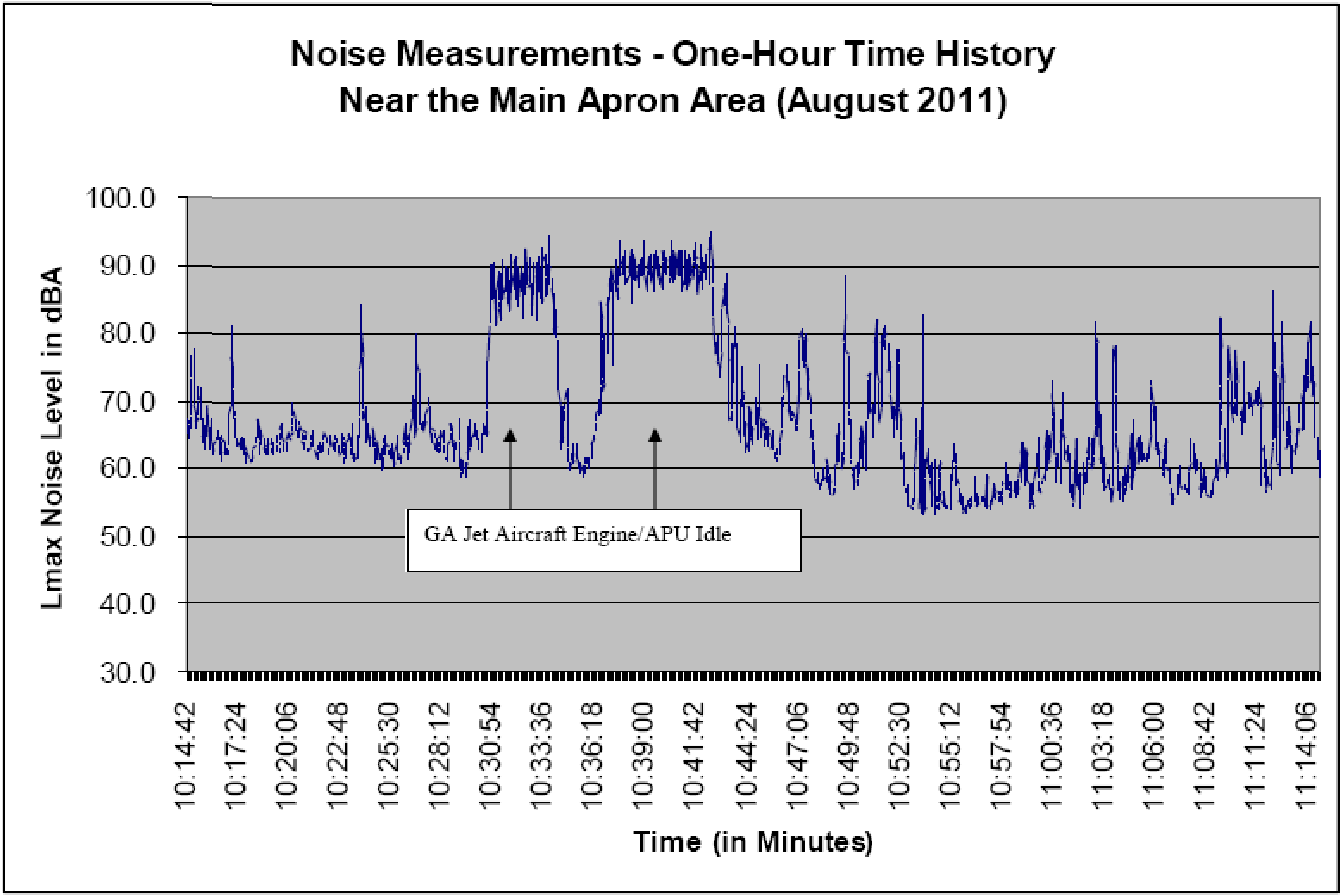



**Figure 7: One-Hour Time History of Lmax Noise Levels Obtained Near the Main Apron Area**

## Noise Mitigation

This section of the report addresses potential noise mitigation measures that could be implemented to reduce the noise from aircraft ground operations in the South Apron Extension area from impacting the nearby residents. Possible noise mitigation measures could include noise barriers, an earth berm, aircraft hangers, or some combination of these measures that would be located along the property line of the Airport. This noise assessment also evaluated the effectiveness of different barrier heights in reducing the noise levels.

A noise barrier is a solid structure that intercepts the direct sound path from the source (aircraft) to the receiver (residence). It provides a reduction in noise level within the 'shadow zone'. Figure 8 illustrates the geometrical aspects of a noise barrier where no extraneous surfaces reflect sound into the shadow zone. The shadow zone is defined as the area behind the noise barrier that extends from the diffraction angle line to the ground.

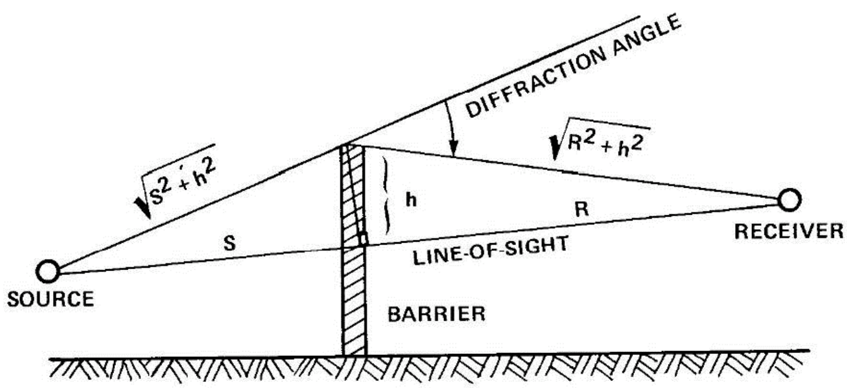



**Figure 8: Parameters and Geometry of a Noise Barrier**

The insertion loss (noise reduction) provided by a noise barrier is a function of the path length difference between the actual sound path traveled and the line-of-sight direct path distance. In Figure 8, the line-of-sight distance is (S+R), while the sound path traveled has the distance = square root($S^2$+$h^2$) + square root($R^2$+$h^2$). The dimension h is the perpendicular height of the barrier that extends above the line-of-sight. The same geometric parameters apply whether the noise barrier is a wall, earth berm, or aircraft hanger.

Path Length Difference = $(\sqrt{S^2+h^2} - S) + (\sqrt{R^2+h^2} - R)$

Table 2 shows the insertion loss of a solid noise barrier when there are no surfaces that reflect sound into the shadow zone, and the sound transmission loss of the noise barrier is at least 10 dB greater, at all frequencies, than the insertion loss expected from the noise barrier. The noise barrier material whether made of wood, pre-cast concrete panels, metal, earth berm, etc. that has a density of at least 4 pounds per square foot would meet this requirement. The limiting value of about 24 dB is caused by scattering and refraction of sound into the shadow zone. For large distances, this scattering and bending of the sound waves into the shadow zone would reduce the effectiveness of the noise barrier.

**Table 2: Typical Insertion Loss of a Solid Noise Barrier**

| Path Length Differ-ence (ft) | Insertion Loss, dB Octave Frequency Band, Hz | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 31 | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
| .01 | 5 | 5 | 5 | 5 | 5 | 6 | 7 | 8 | 9 |
| .02 | 5 | 5 | 5 | 5 | 5 | 6 | 8 | 9 | 10 |
| .05 | 5 | 5 | 5 | 5 | 6 | 7 | 9 | 10 | 12 |
| .1 | 5 | 5 | 5 | 6 | 7 | 9 | 11 | 13 | 16 |
| .2 | 5 | 5 | 6 | 8 | 9 | 11 | 13 | 16 | 19 |
| .5 | 6 | 7 | 9 | 10 | 12 | 15 | 18 | 20 | 22 |
| 1 | 7 | 8 | 10 | 12 | 14 | 17 | 20 | 22 | 23 |
| 2 | 8 | 10 | 12 | 14 | 17 | 20 | 22 | 23 | 24 |
| 5 | 10 | 12 | 14 | 17 | 20 | 22 | 23 | 24 | 24 |
| 10 | 12 | 15 | 17 | 20 | 22 | 23 | 24 | 24 | 24 |
| 20 | 15 | 18 | 20 | 22 | 23 | 24 | 24 | 24 | 24 |
| 50 | 18 | 20 | 23 | 24 | 24 | 24 | 24 | 24 | 24 |

In general, any noise barrier that blocks the direct line-of-sight between the noise source and the receptor would provide a noise reduction of at least 5 dBA. The noise reduction increases as the height of the noise barrier increases, resulting in a greater path length difference. In addition, a noise barrier is most effective when it is located either near the noise source or the receptor since this would result in an increase in the path length difference. Figure 2 shows that the nearest residential receptors are located along the airport property line indicated by the Airport Perimeter Road adjacent to noise measurement Locations 1 and 2. A noise barrier, earth berm, or aircraft hangers located along the airport property line would be the most effective location and would provide the greatest amount of noise reduction for the residents at measurement Locations 1 and 2.

For the noise barrier analysis, noise source heights of 6 and 8 feet for the GA jet aircraft engines during ground operations (approximate engine centerline height above ground) were used in the barrier noise calculations. The noise barrier calculations also assumed that the distance from the aircraft ground operations at the center of the South Apron Extension area was 200 feet from the noise barrier, and the residential receptors at Locations 1 and 2 were located approximately 30 feet from the noise barrier at a height of

5 feet above ground. The noise calculations were performed for different noise barrier heights of 10, 12, 15, 20, and 25 feet. These parameters were used to calculate the path length difference associated with each of the different noise barrier heights. The path length difference was then used to determine the amount of noise reduction (from Table 2) provided by the different noise barrier heights. The results of the noise barrier calculations are shown in Table 3 from the aircraft ground operations in the South Apron Extension area. These results indicate that a 10-foot high noise barrier would provide a noise reduction of approximately 11 dBA at residential receptor Locations 1 and 2 from aircraft ground operations in the South Apron Extension area. The amount of noise reduction increases with increasing barrier height. A 12-foot high noise barrier would provide a noise reduction of approximately 14 dBA. A 15-foot high noise barrier would provide a noise reduction of approximately 16 dBA, while a 20-foot high noise barrier would provide a noise reduction of approximately 19 dBA. An aircraft hanger (or noise barrier) at a height of 25 feet would provide a noise reduction of approximately 21 dBA. The noise calculations indicate that there is very little difference in the amount of noise reduction based on the different aircraft engine heights of 6 and 8 feet used in the calculations. The increase in engine height reduces the effective height of the noise barrier, resulting in a slight decrease in the path length difference. As a result, there is a slight decrease in the amount of noise reduction provided by the noise barrier.

**Table 3: Noise Reduction at Residential Receptor Locations 1 and 2 from Aircraft Ground Operations in the South Apron Expansion Area**

| | Noise Barrier Height | | | | |
|---|---|---|---|---|---|
| | 10 feet | 12 feet | 15 feet | 20 feet | 25 feet |
| Aircraft Engine Height – 6 feet | 11.5 dBA | 13.9 dBA | 16.6 dBA | 19.7 dBA | 21.5 dBA |
| Aircraft Engine Height – 8 feet | 11.3 dBA | 13.7 dBA | 16.5 dBA | 19.5 dBA | 21.4 dBA |

Noise barrier calculations were also performed for aircraft operations on the Runway 6/24 taxiway. The taxiway is located approximately 575 feet from the noise barrier. All other noise barrier parameters are the same as those used in the noise calculations for Table 3. The results of the noise barrier calculations from the aircraft taxiway operations are shown in Table 4.

**Table 4: Noise Reduction at Residential Receptor Locations 1 and 2 from Aircraft Taxiway Operations**

| | Noise Barrier Height | | | | |
|---|---|---|---|---|---|
| | 10 feet | 12 feet | 15 feet | 20 feet | 25 feet |
| Aircraft Engine Height – 6 feet | 10.7 dBA | 13.2 dBA | 15.9 dBA | 19.1 dBA | 21.1 dBA |
| Aircraft Engine Height – 8 feet | 10.6 dBA | 13.1 dBA | 15.8 dBA | 19.0 dBA | 21.0 dBA |

The results of the noise barrier analysis indicate that a 15-foot high noise barrier would provide a noise reduction of approximately 16 dBA at residential receptor Locations 1 and 2 from aircraft ground operations in the South Apron Extension area. In general, GA aircraft activity at the proposed South Apron Extension area is only expected to occur during the summer months, especially on busy summer weekends, when the GA aircraft activity at the Airport increases significantly.

Another concern is the trees that currently form a buffer zone between the nearest residences and the airport that would be removed and the area paved over as part of the proposed South Apron Extension project. This tree zone is approximately 250 feet in depth and could provide 5 to 8 dBA of noise reduction from the existing aircraft operations on the taxiway, and from aircraft takeoffs and landings on Runway 6. A noise barrier along the airport property line would also compensate for the loss of the noise reduction provided by the tree zone.

**Summary**

The results of the 24-hour noise measurements obtained at the residential receptor Locations 1 and 2 indicate that the DNL noise levels in 2012 were slightly lower than the noise measurements obtained in 2011. However, this decrease in the measured DNL noise levels may be due to a reduction in the amount of aircraft activity at the airport in 2012, especially in the number of GA jet aircraft operations.

The hourly Leq(h) noise measurements of the aircraft ground operations obtained at the Main Apron area were similar to the Leq(h) noise measurements obtained in 2011. However, the noise measurements indicate that the duration of the GPU idling time for the GA jet aircraft was lower in 2012 (2 to 4 minutes) than in 2011 (4 to 8 minutes). This indicates that there has been some benefit from the Airport's voluntary policy on APU operating restrictions.

The results of the noise barrier analysis indicate that a 15-foot high noise barrier would provide a noise reduction of approximately 16 dBA at residential receptor Locations 1 and 2 from aircraft ground operations in the proposed South Apron Extension area. In addition, the noise barrier would also compensate for the loss of the noise reduction provided by the existing tree zone.

# Attachment A

# Nantucket Memorial Airport

# APU Operating Restrictions

# Voluntary Policy

# NANTUCKET MEMORIAL AIRPORT

14 Airport Road Nantucket MA 02554
phone 508.325.5300 fax 508.325.5306

Airport Administration
Passenger Services
FBO Services
ACK AirportMonitor™
Airport Statistics
Noise Abatement
Master Plan
Job Opportunities
ACK Knowledge

## APU OPERATING RESTRICTIONS

ACK HOME

Nantucket Memorial Airport has received complaints from neighbors adjacent to the South Ramp concerning increasing aircraft Auxiliary Power Unit noise and emissions. As a result, the Nantucket Memorial Airport Commission has adopted the following voluntary policy on the use of APU's.

APU USE IS PROHIBITED

*Except....* **To enable an expedited start up**

*- OR -*

**When approved by Airport Operations Supervisor.**

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**GPU is available upon request. (DC only)**

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**Please assist us by adhering to the following guidelines:**

- **Request external power (GPU) whenever possible.**
- **Limit APU use to the minimum required for preflight/postflight.**
- **Turn off bleed air for air conditioning to reduce APU noise and emissions.**
- **Request alternative parking if extended APU use is required.**